NATURE

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PROPAGANDA IN EUROPE

IN the recent debates in Parliament, with their striking vindication of parliamentary institutions, and in particular of the value of the House of Commons as a direct supervisor of departmental activities, there have been two main points of criticism or concern. The first of these, the question of man-power and production, has already been discussed in these columns. The second, that of propaganda and the work of the Ministry of Information, including the British Broadcasting Corporation, acquires greater importance with the abandonment by Allied troops of their remaining foothold on the mainland of Europe, no less than with the latest agreement of the Vichy Government with Germany.

Much has been heard in the last seven months of the 'New Order' which Germany will introduce, or is introducing, in Europe. That design for a new economic order is becoming clearer and its features have been admirably outlined in recent publications*. There can be no question as to the urgency of meeting that challenge now in the diplomatic field as well as in that of arms, of exposing the real nature of the German 'New Order' and of expounding the alternative which we have to offer. To allow that challenge to go by default and to fail to refute emphatically and authoritatively the insinuation that we stand for the old order or disorder, and that our only aim is to restore the *status quo* in Europe and to maintain it at home, may do irreparable harm to our cause, both in Europe and overseas.

The publications already mentioned afford invaluable equipment for at least a part of that task. Mr. Duncan Wilson shows clearly how the new order has already meant the wholesale robbery of occupied Europe for the benefit of Nazi Germany, even to the point of actual starvation, and the forced mobilization of labour for Nazi war purposes. The scheme is to be forced on the world by ruthless war, for the exploitation of industry, capital and man-power from one end of Europe to the other, solely to increase the wealth and to strengthen the arms of the Nazis. The 'New Order' is only the old order of exploitation, successively manifested in Germany, the Balkans and the occupied territories of Western Europe since 1933.

Mr. Wilson, however, does not leave it at that. He points out how carefully this 'New Order' propaganda campaign, since Germany gained control of Western Europe in June 1940, is timed to fit in with a strategic plan. The Germans are playing skilfully on the general desire in Europe and America for economic stability, which they promise the 'New Order' will achieve. They do not mention the price of complete political subjugation to be paid by its victims in Europe, or the dominating position it would give to Germany in the markets of the world. They carefully conceal its weaknesses—the reaction in Germany and the occupied territories, and the strain which resistance is already placing on German administration, so that it is already fair to conclude that Hitler can no more bring peace to Europe than he cares to bring it freedom.

The Royal Institute of International Affairs fully corroborates, with its detailed analysis, Mr. Wilson's conclusions. Its careful examination of the German long-term plan for an economic new

* "Europe under Hitler: in Prospect and in Practice." (London: Royal Institute of International Affairs.)
"Germany's 'New Order'." By Duncan Wilson. (Oxford Pamphlets on World Affairs, No. 46.) Pp. 32. (Oxford: Clarendon Press; London: Oxford University Press, 1941.) 4d. net.
"Hitler's 'New Order' in Europe." By Paul Einzig. Pp. xii+147. (London: Macmillan and Co., Ltd., 1941.) 7s. 6d. net.
"The Two Orders", *Round Table*, March, 1941. (London: Macmillan and Co., Ltd.) 5s. net.

order in Europe and of the probable effects of its application with reference to the central trends and problems of European economy and the place of that economy in the world as a whole, is searching and authoritative, and is substantiated by an account of the German exploitation of the occupied countries which leaves no room for doubt as to the real nature of the oppression masquerading under the name 'New Order'.

The evidence thus assembled shows clearly that the German policy is to incorporate in the Reich, or, where this is not expedient, to buy up, all the main manufacturing capacity of the Continent, and to trade on terms which may be pushed far in her own favour, with the purely complementary and raw-material producing countries outside her new boundaries. This policy involves the growing impoverishment of the rest of the Continent and the permanent exploitation of 70 per cent of the population of continental Europe, excluding Russia. Moreover, this policy is only part of a scheme for world domination. It appears to envisage putting Africa under the same subjugation, and its attitude to the western hemisphere is clearly that the new Europe is to be independent of the western hemisphere, trading on Germany's own terms purely as a means of raising standards of living above the necessary minimum.

"Europe under Hitler" shows clearly enough how the American peoples would suffer from this system, which would be no better for the outside world than for Europe. Fortunately, it has already been made plain that the United States are fully alive to the implications of such a permanent organization of 325 million people for the support of a war machine having at its disposal material resources almost as great as their own, and headed by men prepared to use it ruthlessly for any purpose which their ambition may suggest. It is by no means clear, however, that the British Government is alive to all the implications arising out of the facts and position disclosed in these analyses.

In the first place, it is of the utmost importance that we should expose to the utmost of our power the weaknesses and the fallacies of the German plan for Europe. Our propaganda must be as widespread and effective as the Nazis', exposing its falsehoods and encouraging the resistance in the occupied territories, which are already taxing Nazi strength and thwarting its purpose. Recent uneasiness about the Ministry of Information and British broadcasting has largely been due to doubts as to whether such propaganda is being carried out on a wide enough basis, and with sufficient purpose and skill to achieve its objective. There is insufficient evidence that it has been given its proper place in our war strategy and directed and executed with the vigour and enthusiasm essential to success.

The second point concerns the elaboration of British proposals for a new Europe. It would be most unwise to concentrate exclusively on exposing the negative sides of the German plan for Europe, glaring as they are. It would not even be an effective reply to his propaganda about our own exploitation of Europe and pretence that he is liberating Europe from the economic tyranny of Britain. Nor can we assume that liberating Europe from Nazi domination means reversing the whole process of economic integration which has been set in motion. We need a more unified Europe, but must attain it by other methods and for other purposes than those of the Nazis. The new order in Europe must seek to create new ties, not to dissolve old ones; to build up, not to destroy.

This is the truth which lies behind projects like the United States of Europe or Federal Union; the practical issue at the moment, however, is not the discussion of legal forms but the consideration of the fundamental issues of European order, the problem of combining individual liberty with the authority essential for social cohesion. Without some measure of pooled resources and central control, European civilization cannot survive, and that concentration can only be achieved by the creation of common loyalties and by a sense of common values.

This has already been recognized by the small nations, as was shown by the acting Norwegian Minister for Foreign Affairs, Mr. Trygve Lie, in a recent broadcast from London to the Norwegian people. Mr. Lie recognized that the alternative to the tyranny of the Nazi 'New Order' is co-operation with the free peoples, and his courageous and heartening words indicate that this co-operation is not limited in Norwegian eyes to the immediate purpose of victory and liberation, but implies "a state which must and shall endure after the war".

Such a declaration implies further responsibilities for Great Britain. The abandonment of a policy of isolation and neutrality can be neither negative nor unilateral. We must be prepared to play our part in this new conception of European order and to continue after the War the planned co-operation already begun under its exigencies. In consultation with those countries which now share with her the

fortunes of war, Great Britain must at least lay the foundations of a new economic order which will take account of their interests as well as her own, and will enable their industries and their agriculture to flourish side by side with her own.

Something more than this, however, is involved in an effective reply to the Nazi policy and tyranny. It is not enough to develop by persuasion and negotiation a European federation or system of freer trade, stable rates of exchange and greater economic regions. The democratic order implies indeed an international association with certain machinery, for which the League of Nations provides precedents and lessons. It implies participation by all countries which believe in freedom rather than tyranny, in persuasion rather than force, so that there is sufficient good will to outweigh any possible ill will. But to work the new machinery a new spirit is wanted.

The admirable article in the *Round Table* derives its special value from its insistence on this point. The new order towards which the free peoples are groping can only be brought forth under the dynamic inspiration of a great ideal, and the formulation of this ideal is indeed an essential part of our war strategy if we are to meet the almost fanatical devotion which Hitler has inspired for their ideal in the German people. To the courage, endurance, self-sacrifice and faith of the nations which believe in justice and liberty there are indeed clouds of witnesses. Their ideals await expression in prophetic utterance.

We have not, as the *Round Table* reminds us, developed the outlook demanded by modern conditions. While science has abolished distance, unified the world, and made five continents adjacent countries, we are still inclined to retain the isolated, provincial minds of an age to which steam and electricity were unknown. The next stage in human progress is to discard the idea that self-preservation and national interest should be the only principles which determine foreign policy; and to believe that all nations, within the limits of their powers, have a duty to help actively to make justice, mercy and freedom prevail, and that the iniquity of the sufferings of other peoples are not merely their own concern but even a disgrace to the world. Only when that day dawns shall we have acquired a mind adequate to the conditions of modern civilization, and discovered an ideal more inspiring and effective than that offered by the Nazi regime.

AFRICAN SURVEY

Focus on Africa

By Richard Upjohn Light. (American Geographical Society, Special Publication, No. 25.) Pp. xv+228 +145 plates. (New York: American Geographical Society, 1941.) 5 dollars; 3 dollars to Fellows.

DR. LIGHT'S book presents us with a new technique in the methods of study travel in Africa—the use of the private aeroplane. Travel by motor-car has many obvious advantages for the student of African conditions, but is subject to two serious drawbacks. In eastern and equatorial Africa and some parts of West Africa, the traveller is confined during the rainy season to a few all-weather roads. Moreover, the great distances impose on him at all times an irritating waste of time. One is apt to forget, for example, that the area of French West Africa is greater than that of the Indian Empire; that the Belgian Congo is five times the size of France; or that the Union of South Africa, including its mandate, has four times the area of Germany. Here the aeroplane certainly has the advantage. But there is at present a very grave obstacle in the paucity of landing grounds and of metereological information, away from the main routes taken by commercial airways. Dr. Light's journey took him from the Cape, through the Rhodesias, Tanganyika, Kenya, Uganda and the Sudan, to Cairo. Air facilities are good in the Union, and fairly well developed in Southern Rhodesia; in Northern Rhodesia and East Africa they are very limited. It would have been interesting had Dr. Light's journey allowed him the opportunity of comparing conditions in the Belgian Congo, where the authorities appreciated, at an early date, the value of internal air communications, and have for a number of years maintained an efficient local service through the Sabena organization.

Dr. Light, unlike many of his predecessors in African air travel, has brought a trained scientific mind to bear on what he has seen in Africa. He is a physician who has devoted himself to the surgery of the brain and spinal cord. But he has also had a long experience of flying, in the course of which he has made a photographic reconnais-

sance of parts of the Rocky Mountains, and has completed a seaplane voyage round the world. This combination of man of science and competent airman must be rare. It is characteristic of the spirit in which he made this journey that, before setting out, he had (as his work indeed amply proves), made a very thorough study of the conditions of the territories he was to visit. His statements of fact are well documented, and the reader has the advantage of a well-selected bibliography of works on the current scientific and sociological problems of Africa. He had the good fortune to enlist the interest of the American Geographical Society of New York, and it was doubtless its generosity which enabled him to furnish the reader with maps on a far more liberal scale than most contemporary writers have found possible. There are no fewer than three hundred aerial photographs in this volume. They are of unusual excellence, and Dr. Light was indeed fortunate in having in the person of Mrs. Light a companion who was obviously so skilled in the use of the camera.

Dr. Light would no doubt himself agree that his book is of the character of a reconnaissance rather than of an attempt to make any original contribution to our knowledge of Africa. But it has a somewhat subtle merit of its own, and one which gives it a very real value. At the end of an attractive and pleasantly told narrative (including an interesting account of a visit to the game reserves on the Serengeti plains), the general reader will find himself in possession of a knowledge of African problems which he himself would scarcely have sought in specialist studies, and would not have found in the lighter type of travel book. Dr. Light comes nearest, perhaps, to an original contribution to our knowledge of Africa in his aerial studies of Kilimanjaro (where his photographs afford a useful supplement to those of the Swiss aeronaut, Walter Mittelholzer), the Ngorongoro crater (which still offers problems on which geologists hold conflicting views), and, above all, of the Ruwenzori massif. Cloud and rain conditions have always given this mountain an elusive character. Though the neighbouring territories had frequently been traversed before 1888 by competent observers, it was not until that year that Stanley and Stairs proved to an incredulous world the existence of its snow peaks. Its physical features have since become well known through Sella's wonderful photographs (taken during the Duke of Abruzzi's expedition), and the accounts given by Humphreys, Tilman and Shipton, and by the later Belgian and German parties. But aerial photographs are limited to those which Humphreys, after many disappointments, succeeded in taking in 1931. Dr. Light had also some disappointments, but it is fortunate that in the end a clear day permitted him to give us the excellent views which form Nos. 193–213 of his series. HAILEY.

CAMOUFLAGE IN WARFARE

The Art of Camouflage

By Lt.-Col. C. H. R. Chesney. With four Chapters by J. Huddlestone. Pp. 252+12 plates. (London: Robert Hale, Ltd., 1941.) 8*s*. 6*d*. net.

TO the evolutionary biologist, especially if he is a field naturalist with tropical experience, there are few subjects more fascinating than the camouflage devices of the animal kingdom. It is only recently that NATURE reviewed what must remain for many a day the greatest comprehensive work on this subject, H. B. Cott's "Adaptive Coloration in Animals" (NATURE, **146**, 144; 1940).

I had the advantage in my early days in the Gran Chaco of coming into very intimate contact with the subject both as a biologist and as one depending for his food on his success as a hunter. This experience incidentally drove home the fact, by no means generally appreciated, that there is a fundamental difference between the camouflage of small animals and of large. In the former, such as insects or small lizards, the dominating principle is that of imitative colouring to resemble the background or surroundings and in this group occur by far the most perfect examples of animal camouflage. The most common of Nature's backgrounds—the chlorophyll green of vegetation—finds an astonishingly perfect match in many animals—for example leaf insects or tree frogs or certain parakeets. Even within the limits of the group of parrots the imitative coloration is no longer found in the larger representatives, such as macaws or cockatoos. Among the larger animals in general it is absent, even where green vegetation forms the normal background.

The explanation of this curious fact is that the obliterative effect of imitative colouring becomes in a larger animal overborne by the effect of light and shade in showing up the modelling or relief of the body, precisely as an artist would depict it by the shading of his pencil or pastel drawing. To secure effective camouflage, Nature simply obliterates these differences in shade: the high lights on the back by dark pigment; the shadow underneath by white; and between these

two extremes by compensative or counter-shading so as to cancel out exactly the differences in intensity of illumination. This counter-shading is the basic factor in the camouflage of many wild creatures in which the bulging relief of the body, so conspicuous in an ordinary domesticated animal, seems entirely flattened out.

Apart from its relief, the nature of a large object is commonly recognizable from its forming a continuous patch of colour or tone bounded by a characteristic outline. This is effectively counteracted in certain animals by a method totally different from counter-shading, namely, the so-called 'dazzle', in which the body bears a pattern of violently contrasting tones, such as the black and pale yellow of the zebra or jaguar. The functions of this 'dazzle' are two, namely, (1) disruptive, in that it breaks up the apparent continuity of surface and outline, and (2) distractive, in that its violent pattern grips the attention so that the fleeting glance fails to call up the mental picture of the particular animal.

It was when present at the opening of the Kiel Canal in 1895 that the sight of the obliteratively coloured warships of Germany and France in their uniform 'battleship grey' led me to realize the extent to which man in his war camouflage falls short of what is attained by Nature in the animal kingdom. The effect of the grey coloration was obviously interfered with by differences in light and shade, which detracted from the obliterative effect not merely of the ship as a whole but still more so in the case of those details which on one hand betray the character of the ship and on the other hand, through their perspective, play an important part in showing how the ship is heading. No attempt had been made to counteract those disturbing effects by the application of counter-shading; nor had any attempt been made to obscure the form of the ships or of their details by destroying the obvious continuity of their surface and outlines by the employment of 'dazzle'.

It was this experience at Kiel, superimposed on the earlier experiences in South America, that led to my taking up seriously the subject of war camouflage and suggesting—apparently for the first time—that war camouflage, so far as camouflage by means of paint is concerned, must, to secure full effectiveness, be in accord with those principles, (1) counter-shading and (2) 'dazzle', to which is due the effectiveness of camouflage in the larger animals. These suggestions were communicated to the Admiralty and War Office during the War of 1914–18 and simple instructions as to carrying them into effect were promulgated to the Fleet in November 1914 and will be found reprinted in the *Nautical Magazine* of July 1940. The soundness of these general principles must be borne in mind by anyone criticizing either the carrying out of camouflage in practice or its literary exposition.

Lieut.-Colonel Chesney has produced a readable volume on the art of camouflage. Its contents are in some respects of an unexpected nature. The introductory section by J. Huddlestone deals with various general considerations (in which it is pleasant to note the tacit admission of the part played by the coloration of animals in providing the foundations for the subject). This section of some forty pages is followed by one of seventy-two entitled "Material Camouflage", and this in turn by the concluding section of some eighty pages devoted unexpectedly to "Strategic Camouflage"—the camouflage of military intention—including chapters on Napoleon, Stonewall Jackson, the Boer War, and the War of 1914–18.

Though the whole book is thoroughly readable, it is the section entitled "Material Camouflage" which will attract the ordinary reader desirous of obtaining information about war camouflage in the ordinary sense. For camouflage in Nature he will turn to the great work by Cott: for strategic camouflage he will consult the military historian. Parts of this section are excellent, more especially those parts which deal with the author's own valuable work during the War of 1914–18. In introducing his story of camouflage during that war, the author remarks that "camouflage in practice is not so much a matter of making dream pictures as of organization and practical adaptation of materials". There is much truth in this statement, which expresses quite fairly the attitude of those responsible for camouflage work during the former war. Its fault and theirs lay in the apparent unawareness of the teachings of Nature and her demonstration of the overwhelming importance of the principles of counter-shading and dazzle. In stressing the importance of organization it seems strange that there is no mention of Mr. Norman Wilkinson, who did so much in the way of organizing the large-scale application of dazzle to ships during the later stages of the War. This is not the only strange omission in Colonel Chesney's book: I find nowhere any mention of Dr. Hugh Cott, to whom the country owes the first demonstration—within the last year—of the marvellous potentialities of counter-shading when carried out under the supervision of a scientific expert.

The really valuable kernel of the book is to be found in the latter part of Chapter v, with its most interesting account of the use of net camouflage; in Chapter vi on civil camouflage; and in Chapter vii on military camouflage in the future. These are well worth perusal: they put clearly and effectively many considerations of importance

which, embodied in an attractive popular work, may perhaps gain more attention from the powers-that-be than when urged privately by the scientific specialist. Such points are the importance of developing the use of smoke screens on land, the use of black paint, the reduction in height of hangars and other buildings, the use of growing trees (but the absurdity of merely painting trees upon the walls of an edifice), and the dispersal of accommodation in a number of small buildings irregularly sited.

The author is sceptical about the efficacy of ship camouflage, but it should be borne in mind that in the War of 1914–18 this was restricted to dazzle, without the necessary scientific supervision and unaided by counter-shading, and that even with these imperfections it was regarded as of distinct use by the mercantile marine and by hard-headed underwriters.

When a new edition is called for, no doubt the author will correct obvious slips and misspellings such as Kallina, Portorus and Sir A. J. Thompson; and he should really look up the history of the word 'camouflage'. JOHN GRAHAM KERR.

INTENSIFICATION OF BRITISH AGRICULTURE

The New Farming: Continuous Cropping by the Wibberley System

By Tom Wibberley. Pp. v+171. (London: C. Arthur Pearson, Ltd., 1941.) 8*s*. 6*d*. net.

DURING the War of 1914–18, the late T. Wibberley published his book "Farming on Factory Lines", in which he advocated more continuous systems of cropping than those generally in use. It was an interesting book, well written, showing on every page the writer's forceful personality; it certainly induced a number of people to examine the proposals even if they were not persuaded to adopt them. Much of the material had been collected while he was in Limerick as agricultural instructor, and later when he was appointed professor of agriculture at University College, Cork, the chair having been specially founded by the late Howard Harrington, who was attracted by the possibilities offered by the system.

Now in this War his son, also T. Wibberley, has revised and reissued the book in the hope that it may prove of value both in the present conditions and in the new ones that will arise when the War is ended. Under the old four-course rotation the arable land is cropped for about 38–40 months out of the 48, and is left bare or in stubble for the remaining eight to ten: broadly speaking for the space of two winters. During each of these it is very desirable that the land should be ploughed and exposed to the frost so that the soil may build itself into the crumb structure so necessary for securing a good seed bed. If the winters are dry and frosty all goes well, but often they are wet and mild and the soil becomes sticky and loses valuable nitrates by leaching. The essence of the "factory lines" methods is to grow crops during these months, so avoiding the loss of nitrate and adding to the total quantity of produce on the farm. The insertion of catch crops is an old device, and has been much practised by the arable sheep farmers on the South Downs and by other groups of farmers, but there were sufficient distinctive features about the Wibberley methods to justify some claim for novelty.

The methods were tested in Ireland and were said to give satisfactory results. In England, on the other hand, catch cropping and continuous cropping have never come into general use on any extensive scale. Autumn-sown crops make but little growth during winter in the drier arable regions of the east, and on the other hand sufficient time must be allowed for cultivation to kill weeds. Attempts at full time cropping have not usually succeeded in these regions, nor did they on Sir E. D. Simon's farm at Leadon Court, Herefordshire, although one readily agrees that if it could be done the results might be valuable. The author's statement on p. 52 that his father in one year turned out beef and mutton to the value of £5,188 14s. 7d., with a total expenditure of £81 2s. 2d. on purchased cakes and meals must make many farmers' mouths water, especially when one is told that this was largely done with tares and winter green crops. The farmers' reaction would almost certainly be: if this young man was brought up to such a lucrative system of farming, why did he ever leave it?

The old four-course rotation has been much altered in its details, and wherever possible it is certain that farmers will grow catch crops, and increase their output of fodder in every way possible. What, however, is needed in regard to the present proposals is not more writing or propaganda about them, but to put them into practice on some actual farm so that other farmers can see what they are like in operation. If the author could bring this about he would soon be able to show whether the returns justify the labour and money involved. E. J. RUSSELL.

The Moral Paradox of Peace and War

Conway Memorial Lecture delivered at Conway Hall, Red Lion Square, W.C.1, on March 23, 1941. By Prof. J. C. Flugel. Pp. xi + 52. (London: Watts and Co., Ltd., 1941.) Paper, 1*s*. net; cloth, 2*s*. net.

IN his highly suggestive and constructive Conway Memorial Lecture, "The Moral Paradox of Peace and War", Prof. J. C. Flugel gives us an acute analysis which is as pertinent to our plans for reconstruction as to the building of a world order from which war has been eliminated. Starting with an analysis of the moral qualities which are responsible for the real challenge of war and which have already led to a certain recognition of the need for a moral equivalent of war, he indicates concisely the points at which this challenge must be met in a progressive society in which full expression is given to legitimate desires and aspirations. Notably he stresses the spirit of adventure, with all it connotes of excitement, uncertainty, danger and tenseness or strenuous endeavour. Of this, as well as the social solidarity, the heightened sense of the individual being needed, and the identification with a nobler cause for which he or she is prepared to make any sacrifice, any stable order must take account of, and must seek to satisfy by discovering, a common purpose comparable in intensity with that induced by war. The great task that confronts democracy is to find a formula for integration in harmony with its own essential spirit, which will express our fundamental agreement as to the ultimate goal while preserving our present liberty of thought and discussion as to the best means of attaining this goal. As Prof. Flugel sees it—and in this most scientific workers will concur—we must learn to face the stark realities of man's place in Nature, and find in the challenge and opportunity they afford for the exercise of human genius, combativeness, courage and co-operation, the true moral equivalent of war. R. B.

Aids to Inorganic Chemistry

By R. G. Austin. Pp. x+348. (London: Baillière, Tindall and Cox, 1940.) 5*s*.

THIS small volume is not intended as a complete text-book of inorganic chemistry, but is designed to give students, who have already attended lectures on the subject, a condensed survey of the principal facts. The subject-matter covers the course required by students of pharmacy, medicine, dental and veterinary surgery.

The preliminary chapters are rightly devoted to general topics such as the atomic theory, acids, bases, salts and the periodic classification. Unlike the non-metals, the metals are considered in the same sequence as they occur in the periodic table, and this has enabled the author to stress their family relationships. The medical aspects of chemistry have been emphasized wherever possible, and the reader will find the notes on the physiological action of common inorganic substances both interesting and profitable.

The author states in the preface that "simple interpretations of the mechanism of chemical reactions have been given prominence in order that students may gain some insight into the principles of chemical change"; it is therefore surprising to find that the ionic aspect of inorganic reactions has been almost totally neglected. In spite of this omission, students of medicine and allied subjects, in search of a book containing a wealth of concise factual matter, should find the book a useful aid to their studies. A. C. C.

This Living World

A College Course in Science. By Prof. C. C. Clark and R. H. Hall. Pp. x+519. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 22*s*. 6*d*.

THIS well-written and well-illustrated book can be recommended especially to those teachers in training who expect to teach general biology in primary or secondary schools. It displays an unusually expanded breadth of vision, thus covering all aspects of life and living. Though the book will not satisfy the needs of the student of biology, from the point of view of examinations, it would well form a supplement to his more academic reading.

In a form which combines accuracy with pleasant reading, the book presents the gist of modern knowledge about the living world, with special reference to the physical development of man and the structure and functioning of his body. Thus it is of cultural as well as simply academic value.

Radioactivité et transmutation des atomes

Par Dr Théodore Kahan. (Collection Armand Colin: Section de physique, No. 222.) Pp. 224. (Paris: Armand Colin, 1940.) 15 francs.

DR. KAHAN'S stimulating account of the more recent developments in radioactivity and the artificial transmutation of the elements will be welcomed by all students who require a short up-to-date survey of the subject. It gives a very satisfactory account of the state of our knowledge of α-, β- and γ-ray spectra which is easily followed, and also gives a discussion of the energetics of nuclear changes which is particularly clear and helpful. His treatment of nuclear reactions such as (α, p), (α, n), etc. covers all the more important aspects in a remarkably concise way. The reviewer hopes that this little volume may still be obtainable in Great Britain. L. F. B.

The Study of the Soil in the Field

By G. R. Clarke. Third edition. Pp. 228. (London: Oxford University Press, 1941.) 6*s*. 6*d*. net.

THE third edition of this valuable little handbook of soil survey differs from the second edition only in having an appendix in the form of the instructions to surveyors, accepted by the Soil Survey Conference of Great Britain. This should add considerably to its practical utility. The author states that the time is inappropriate for a revision of the text; nevertheless it is to be regretted that, since the book is apparently (and deservedly) becoming a standard work on soil survey, the opportunity was not taken to remedy some inconsistencies in literary composition and the misuse of abbreviations which have been freely invented by the author and employed often without explanation, leaving their meaning to be guessed by the reader.

EVOLUTION OF FUNCTION IN THE MAMMALIAN ORGANISM

By SIR JOSEPH BARCROFT, C.B.E., F.R.S.

THE life of the mammal is a synthesis of many diverse functions. They range from the digestion of porridge to the performance of Brahms, from snoring to the niceties of mathematical analysis. Here I am concerned neither with the higher faculties of the mind nor with the lower vegetative functions of the body; but merely with that intermediate region of activity which concerns itself with the muscular movements—getting about and the like—these we share with our mammalian relations generally.

A child, for example, learns to walk. It is, so far as locomotion on its legs is concerned, capable of one kind of movement—crude, uncertain toddling. From that movement, however, quite a number of things develop, the initial ability to toddle turns unconsciously into the power either to walk or to run, and these more refined movements, when exploited by conscious intelligence, create the possibility of anything from tap dancing to tight-rope walking.

But instead of interesting ourselves in the variety and complexity of the movements into which toddling may develop, we may look the other way. We may ask: Can it not be that toddling, itself a highly complicated affair, is not a development or differentiation of some much cruder form of movement, and, if so, what is that movement and is it the parent of movements other than toddling, just as toddling is the parent of tap dancing and mastery of the tight rope? By way of parenthesis the words "just as" require a caveat. We ordinarily regard the development of walking from toddling as a question of practice. Can the same be said of intra-uterine movements?

These are the questions which I wish to attack:

(1) What is the most primitive form of movement of which the mammal is capable?

(2) Does this movement differentiate and develop into other and more complicated ones?

(3) If so, are they recognizable as the forerunners of the sorts of movement with which we are ordinarily familiar in life?

Studies of the earliest movements of which the mammal is capable have been made by a number of observers, mostly on small animals with short periods of gestation, and from several points of view.

The sheep, for example, has the advantage over small animals in that development in it is a comparatively leisurely affair and its steps are therefore easily recognizable. To quote Barron, "All the events which take place over two months in the sheep are telescoped into a single week by the rat."

The period of gestation in the sheep is twenty-one weeks—147 days; until the thirty-third day of embryonic life, the organism is not capable of any inherent movement apart from the beating of the heart. At this age it is about the length of the thumb nail and it has taken on the general mammalian form. Its eyes are well developed, its trunk, tail, fore-legs and hind-legs are all there, though in a rudimentary way. The fœtus at this age does not move except in response to a, for it, rather considerable stimulus. This stimulus is quite specific, it must be given in just the right place and the response is perfectly definite. Tap it firmly just under the eye and it will give a twist to its neck. This twist causes the head in the first place to go back, and in the second place to rotate, drawing its nose towards the point of the glass rod, or what not, with which it was tapped. Tapping no other place will elicit a movement.

Why, you may ask, is this particular point on the cheek so different from the rest of the body that a response can be elicited from it and from it alone? There is a very good reason. Here, just beneath the skin, is the end of a nerve. It is the fifth cranial nerve or, rather, a branch of it. It grows down from the brain and will ultimately supply the upper jaw and the nose with sensory fibres. This is the nerve which will impress itself on one's consciousness if one gets a spasm of toothache in the upper jaw or if one smells ammonia. It is perhaps worth noting that regionally it is the nerve which supplies the most anterior part of the body.

In case a sheep were to walk forward (the natural direction of progression) the first bit of it to run into an obstacle would be the tip of its nose, and the nerve which supplies the tip of the nose is the first sensory nerve to give a response. But by the thirty-third day the fibres of the nerve have not yet reached their destination, they have only reached the point under discussion. The reason why the face must be tapped rather sharply is because the immature endings of the nerve are

* Substance of a lecture delivered at the Royal Institution on May 20. The lecture was in effect a description of a film illustrating the work of the lecturer in collaboration with Dr. D. H. Barron. Its format was dictated by that fact, especially as regards absence of documentation. Its documentation and its setting in relation to the work of other observers will be found in Dr. Barron's article "The Functional Development of some Mammalian Neuromuscular Mechanisms" (*Biol. Rev.*, **16**, 1: 1941).

definitely underneath the skin and not in it. The stimulus must be transmitted through the skin to the deeper structure.

The nature of the movement is reflex, that is, it is caused by a peripheral stimulus, which is transmitted to the central nervous system, in this case, the brain, which passes thence to the motor nerve that supplies the neck muscle concerned. That the first movement should be a reflex, or even a movement which involves the nervous system, is not true of all forms of life. Seemingly there is a tendency in the higher forms for neurogenetic movement to appear earlier relatively to myogenic, until, as in the sheep, movements involving the nervous system occur as soon as, or even before, those of a purely muscular character.

So much for the very first movement. In the few days which follow, the principal alteration which occurs is an expansion of that. This expansion takes place in at least four different directions.

(1) The area of skin on the face, the stimulation of which will elicit the movement, becomes greater. Other branches of the fifth cranial nerve, the great sensory nerve of the face, develop, and as they do so the areas of skin which the nerve has reached become sensitive when stimulated and evoke the movement.

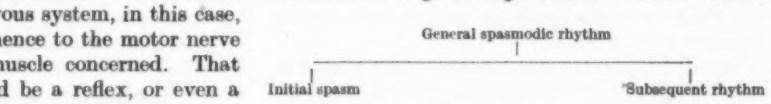
(2) The movement itself embraces an ever-increasing number of muscles, so that instead of being confined to the neck, it spreads within the next week or so to the mouth, the trunk muscles, the limbs and the tail, so that the movement amounts, not to a twitch of the neck, but to a trifling convulsion of most of the body.

(3) More than this, the response extends not merely in the number of muscles which are involved, but it also extends in respect of time. Stimulation causes not merely one spasm but a series of perhaps twenty spasms, one after the other, amounting to a rhythm.

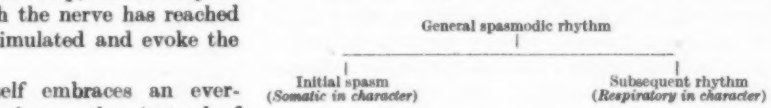
(4) A much less vigorous stimulus will suffice, as it were, to touch off the trigger of this mechanism—a drop of saline on the eye, the direction of a current of fluid into the nose or even a sharp tap on the outside of the sac within which the fœtus floats in its bath of amniotic fluid.

Up to the forty-second day (approximately) the fœtus has exhibited only one kind of movement, the spasm. This may have been more or less widespread, it may have been repeated more or less often, but fundamentally there was but one essential pattern.

Now, however, something quite new is seen. If the fœtus be stimulated, say by a tap on the nose, a rhythm of spasms follows, but the first or first two members of the rhythm differ from the subsequent ones. In the first spasm, the head is thrown back, in the subsequent ones it nods forwards. This is the commencement of differentiation of movement—for slight as is the difference between the initial and the subsequent spasms, that difference develops into something abundantly evident and of great importance. We have then :



To appreciate what has taken place, we have only to pass on a few days. The trifling difference between the initial and subsequent members of the rhythm is seen to denote a definite splitting of function. The initial spasm is shaping towards an indefinite body movement in which the limbs are largely represented whilst the subsequent rhythm affects principally those muscles which are ultimately concerned with respiration. The initial movement gives one the impression that the fœtus is trying to do something; though it is not at all clear what this 'something' may be, the subsequent rhythm gives the impression of the fœtus having been mildly out of breath as the result.



By the forty-eighth or forty-ninth day there is an obvious development of both the somatic and respiratory movements, though in rather different ways. The somatic movement becomes more purposeful in character, the respiratory movement becomes more regulated. Take these movements one by one.

One new element which enters into the somatic movement is gravitational response. When the fœtus is lying on its side, stimulation of the nose causes a twisting of the neck and body, the effect of which is to turn the crown of the head upwards towards the sky. This reaction to gravity is different in some respects from that with which we are familiar in the mature organism. In the latter the semi-circular canals play an active part, but all observers agree that this is not so in the fœtus, or rather in the fœtus at forty-eight days; the response is of a different nature. It is due to the unequal pressure on the two sides of the trunk and perhaps elsewhere. The side on which the fœtus is lying naturally bears its weight, and it seems to be the fact that the pressure on this side is the stimulus to the gravitational response. This may not be the whole stimulus, but whether it is or not, if a piece of cardboard be placed firmly on the upper side of the body so that both sides are pressed upon, the gravitational response disappears.

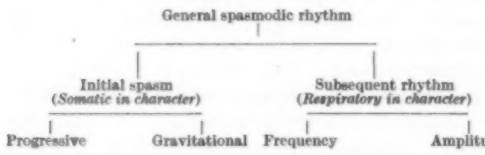
As regards the limb movements: those of the fore-limbs are not symmetrical either. Both are stretched forwards as far as the knee, but whereas the uppermost fore-leg is stretched right out, all the joints being extended, with the lower fore-limb it is different; it is flexed at the knee and the toe is pointed backwards.

The whole movement in a crude way seems to be an effort on the part of the fœtus to rise from the ground, in just the way which it does shortly after birth. The hind-legs are gathered up underneath the belly of the fœtus. If, then, we may stretch the word progression to include rising from the ground, we may regard the movements seen on the forty-eighth day as containing the germ of progressive movement.

As regards the respiratory type of movement* on the forty-eighth–forty-ninth day, two alterations are taking place.

(1) The first is that the respiratory rhythm becomes daily more easy to evoke. By the forty-ninth day almost any muscular movement of the fœtus, however trifling, will touch off a respiratory rhythm; indeed, if at this time the observer lays the fœtus in his hand it is scarcely possible to hold it sufficiently still to prevent stray alterations of tension in the muscles from evoking some response.

(2) The second advance in the evolution of function is the gradation of the respiratory rhythm to correspond with the force of the muscular movement which preceded it. Thus, if the fœtus be held very still, the respiratory responses due to adventitious movements will be relatively slow and shallow, but if the fœtus be given a sharp tap so that it makes a dramatic effort, that effort is followed by a rhythm which is not only more rapid but is also more powerful. We therefore have reached the following position.

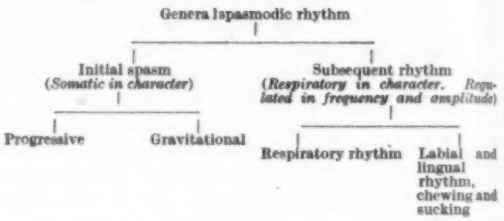


Somewhere about the seventieth day, the movements of the mouth are very prominent. If an object be placed inside the buccal cavity, powerful rhythmic movements are often seen. These resemble both chewing and sucking; it is not quite accurate at this stage to describe them as either, nor is their relation to other movements clear. In this matter, as in many others, we have been helped by the following fact: on exposure or mild asphyxiation of the fœtus, its movements change; those functions of the brain which have been developed most recently are first affected, and therefore as the fœtus during the progress of this experiment deteriorates in vitality, its movements tend to resemble those which it made at an earlier stage of fœtal life. A seventy-day fœtus as it deteriorates will tend in its type of movement shortly to behave like a sixty-day fœtus, then like a fifty-day one, and so on.

In such deteriorating embryos, it may be seen that the rhythmic mouth movements which at seventy days appear to be quite distinct from any others, gradually merge into the general respiratory, from which they have no doubt been differentiated.

I have spoken a great deal about the fifth cranial nerve, and I would end this part of my lecture by collecting some of the points which I have stated about it. The earliest reaction which it gave me was local; as the fœtus grew, the reaction became widespread, but by the seventieth day it has become strictly localized again. I emphasize this sequence because, though exhibited in its most striking form by the fifth cranial nerve, it is true of all sensory nerves, the reaction to stimulation of them being, initially, local, becoming more widespread but finally settling to a local response.

The following chart sums up, so far as we can go here, the information at our disposal about the differentiation of actions of various sorts:



Character of Movement

Hitherto I have spoken of the evolution of a number of actions, if I may describe them by that term, breathing, chewing, getting up and the like. But any of these actions may change in character; it may be rapid, jerky and spasmodic, or it may be drawn out and gradual, or, again, it may even be a sustained movement in which there is an actual static phase, such as the Nazi salute. The evolution of the actions which I have described has all concerned itself with those parts of the central nervous system into which sensory nerves enter and from which motor nerves leave—the hindermost part of the brain (the medulla) and the spinal cord. In general, the organization of action takes place from above downwards, and it is initiated at the point of entry of the nerve which receives sensations from the face and nose and is modified later by influences entering the spinal

* It must not be supposed that these movements cause anything to go into or out of the chest at this age. The windpipe is not open, and owing to the softness of the chest wall no measurable negative intra-thoracic pressure is induced by the rhythmic movements of the diaphragm, the intercostal muscles and the throat muscles.

cord from the arms, the trunk and the legs. But if in the central nervous system this evolution of function takes place from the point of entry of the facial nerve backwards, it takes place in a different sense from that same point progressively forwards. The forward development is concerned less with what the fœtus does, than with how he does it.

The first movement of all was a simple twitch or a minute spasm; when later it became necessary to expand this twitch into something which stretched over a longer time, the expansion consisted of the extension of a single twitch into a series of twitches—a rhythm, but the character of each individual jerk of which the rhythm consisted was unaltered; even when differentiation commenced the twitches were still twitches.

Between the forty-fifth and fiftieth days, however, the movements gradually assume a different character, namely, they take on an air of deliberation; if the arm is thrust out, the movement is less that of the boxer getting in his punch than that of the constable raising his hand to stop the traffic.

Just as the jerky movements obtained from the lower parts of the central nervous system gradually took on a certain appearance of purposefulness and became evidently the forerunners of the types of movement which we actually recognize, so these sustained movements also tend to fall into certain patterns which we recognize as postural. In association with the turning of the neck to which I have already alluded, there are harnessed the corresponding movements of the legs, that is, the fore-leg on the side to which the nose is turned is extended, whilst the other fore-leg tends to be flexed or partially so. At a later date, characteristic postural movements of the hind-legs, the trunk and the eyes are associated with this twisting of the neck. Indeed, it is only necessary to take the head between one's fingers and rotate the neck alternately in one direction and then in the other to produce this corresponding marionette-like movement of the eyes and limbs.

These postural movements are essentially those described by Magnus and de Klejn; the difference between their demonstration of the movements on the adult animal and our own on the fœtus is that they, in order to secure the movements, had to perform a surgical operation in which the mid-brain was relieved of the influence which dominated it, notably the semi-circular canals. In the case of the fifty-five day sheep's fœtus, no such surgical operation is necessary because what Magnus and de Klejn cut away has not at this age functionally developed. The alteration from the simple jerky type of movement to the more deliberate postural type is attributable to this development of the mid-brain and its influence on the centres below it.

The initial phase of postural movement soon disappears; by the sixtieth day, if the fœtus be delivered, it exhibits a different picture, the fore-legs are tensely stretched out side by side, the head and the tail are extended, and the fœtus presents the appearance of an animal suffering from what is known as 'decerebrate rigidity'—a condition which, again, can only be obtained in the adult by a surgical operation, that of severing the foremost parts of the brain from parts behind them, and so ridding these latter from the influence of the higher centres. But once more, in the case of the sixty-day fœtus, no surgical operation is necessary for the simple reason that the higher centres in question have not developed physiologically—function has developed upwards far enough, but only far enough to produce this rigidity.

The picture of rigidity does not last many days. From about the fiftieth day onwards a characteristic has been gradually creeping into the picture, slight at first, but quite evident; by the seventieth day it becomes dominant, namely 'inhibition'. During the eighth and ninth weeks, this growing inhibition amounts to no more than a certain evident restriction of movement associated with the postural patterns which I have described. On the seventieth day, however, if the fœtus be delivered, so far from exhibiting spasmodical or postural movements, it gives the impression of being dead or at all events soundly asleep. If mechanically stimulated, the stimulus must be strong if it is to be effective, and even at that the response is only very restricted. This suppression of movement means that function has progressed well up into the fore brain. That motility has not been abolished but only suppressed is easily proved. It is only necessary to leave the fœtus exposed for a while or to pinch the umbilical cord in order to uncover the functions which I have tried to describe. A more elegant proof is furnished by intra-uterine transection of the central nervous system. It is possible to cut across the brain or cord at any given point, between the fiftieth and seventieth days, without impairing the growth of the fœtus. If, at seventy days, the section consists in mere severance of the cerebral hemispheres from the rest of the central nervous system, no change in the behaviour of the fœtus can be seen, but if the section is lower down—about the middle of the fore brain—the lower parts are freed from 'inhibition' and the fœtus exhibits the 'rigidity' pattern of sixty days. If the section is just below the 'pons Varolii', the fœtus exhibits almost unceasing jerky movements, which are both somatic and respiratory and are strongly reminiscent of a fœtus of about forty–fifty days. At seventy days, however, the fœtus appears to be in a sound sleep and in this sleep we may leave it.

MYOSIN BIREFRINGENCE AND ADENYLPYROPHOSPHATE

By Dr. Joseph Needham, F.R.S., Dr. Shih-Chang Shen, Dr. Dorothy M. Needham and Dr. A. S. C. Lawrence,
Biochemical Laboratory, University of Cambridge

OUR knowledge of the nature of muscular motion has hitherto been divided into two main fields of successful analysis. First there was the discovery of the phosphorylation cycles whereby energy is transferred from carbohydrate breakdown to the muscle fibre; here the earliest landmarks were the investigations of Fletcher and Hopkins[1] and of Harden and Young[2] (see the papers of Parnas[3] and D. M. Needham[4] for up-to-date reviews). Secondly, there was the discovery of the elongated or anisometric character of the particles of muscle-globulin (myosin), demonstrated in the classical paper of v. Muralt and Edsall[5], leading to the application of X-ray techniques to the problem, and the establishment by Astbury[6,7], that muscular contractility is essentially a molecular contractility of protein chains. The exact connexion between these two orders of fact, however, still remains obscure.

In order to bridge this gap, the most promising point of departure seemed to be the important finding of Engelhardt and Ljubimova[8] in 1939 that the enzyme adenylpyrophosphatase is either myosin itself or some protein very closely associated with it. This was confirmed by one of us (D. M. N.) in the following year (unpublished) and recently by Szent-Györgyi and Banga[9]. Its importance lies in the facts: (1) that the breakdown of adenylpyrophosphate is, among the processes of intermediary metabolism in the muscle, that nearest in time to the contraction of the fibrils, and (2) that although some adenylpyrophosphate is broken down by transfer of phosphate to hexosemonophosphate (by an enzyme not present in the myosin fraction), the quantitatively largest part of its breakdown probably occurs by splitting off of free phosphate under the influence of the enzyme adenylpyrophosphatase. It was thought of interest, therefore, to study the effect of adenylpyrophosphate upon the flow birefringence of myosin. The myosin sols were contained in a small annular cell holding just less than 1 c.c., mounted on the fixed stage of a Swift-Dick polarizing microscope, and having the outer co-axial cylinder driven at speeds variable up to 500 rev./min. (shear-rate 4·08 cm./cm./radian). Myosin preparations were also examined at higher dilutions in the co-axial viscosimeter referred to in a recent communication in Nature by Lawrence, Needham and Shen[10] (shear-rates of 0·73 and 4·2 cm./cm./radian according to the diameter of the inner cylinder used).

Myosin preparations showing strong flow birefringence (Δ 50–80°; Ψ 50–60° for 1–2 per cent sols at 20° C.) were obtained from rabbit muscle by the usual method. Until this year, myosin sols prepared in Cambridge had nearly always been non-birefringent, and although the reason for this is being made the subject of a special study by Dr. K. Bailey, it may be said here that, provided the rabbit has been starved for twenty-four hours before death, the myosin never fails to show flow birefringence*. In the light of observations such as those reported below on the viscosimetry of myosin, it is likely that these differences are simply due to the size and shape which myosin particles assume when extracted from muscle cells under different conditions. Some preparations of myosin, however, which do not show flow birefringence, may show anomalous flow at low shear-rates, and are then analogous to the preparations of globulin from amphibian embryos described by Lawrence, Needham and Shen[10].

If now a myosin sol containing about 3 per cent of the protein is mixed with adenylpyrophosphate at *p*H 7·0, a considerable decrease in the flow birefringence intensity is immediately observed, for example, 65°–45° (see Fig. 1). This fall occurs in less than a minute at room temperature, but at 0° C. is so lengthened as to allow of its being plotted on a curve. With adenylic acid or inorganic pyrophosphate, the fall is either absent or slight. An important feature of the effect is that it is reversible; after it has occurred, the flow birefringence intensity of the sol rises, reaching its original level in about 2 hr. at 37° C. or overnight at room temperature, and then rising beyond it. It may be added that strict control of the salt concentration is essential, since if increasing amounts of solid potassium chloride are added to a white, almost salt-free, gel of myosin, the flow birefringence intensity continually decreases to reach a minimum at molar concentration, when the sol so formed is most transparent. After that point, with increasing amounts of the salt, the flow birefringence intensity increases, apparently because of the increasing amounts of transparent gel formed by salting-out. Hence in the above-mentioned experiments the ionic strength of the adenylpyrophosphate or other substances added was compensated for in such a way as to bring all

* The suggestion that the state of nutrition might be a factor was due to Dr. H. Lehmann.

samples to a final concentration equivalent to the ionic strength of 0·75 *M*KCl. In order to avoid the effects described by Edsall and Mehl[11], potassium was the only cation present. Finally, viscosimetric measurements indicate that the relative viscosity decreases, but not the anomaly of flow (see Fig. 2*a*).

Interpreting the effect, we consider that the first change is a moderate shortening of the myosin particles, with or without a certain amount of disaggregation. This seems not quite analogous with the changes produced by increasing potassium chloride concentrations below molar, for here, although the flow birefringence intensity also falls, and correspondingly the relative viscosity, the anomaly of flow decreases and eventually disappears. Hence the particles must become drastically shorter as well as possibly smaller. After the molar point is passed, though flow birefringence and relative viscosity increase, the viscous anomaly does not again become observable, probably because although the particles lengthen, their axial ratio decreases owing to some form of aggregation. In all such explanations we provisionally ignore the role of intermicellar forces (*cf.* Langmuir[12]) which may well be of importance in the relatively dilute solutions we have used, and must almost certainly be so in more concentrated mixtures such as occur in the muscle fibril itself.

The subsequent rise in flow birefringence intensity during the action of the enzyme, however, is more difficult to interpret, since that of myosin sols in potassium chloride alone will, if placed at 37° C., steadily increase until they set to a thixotropic gel. We have frequently observed in this respect what may be a protective action of adenylpyrophosphate,

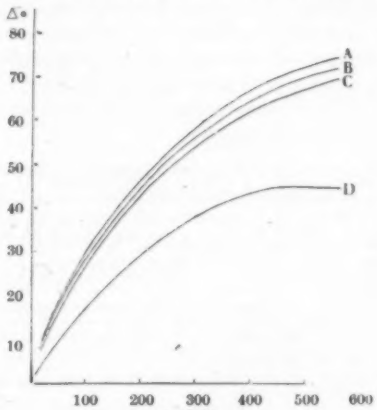


Fig. 1.

REDUCTION OF FLOW BIREFRINGENCE OF MYOSIN BY ADENYLPYROPHOSPHATE.

A, POTASSIUM ADENYLATE; *B*, CONTROL; *C*, POTASSIUM PYROPHOSPHATE; *D*, POTASSIUM ADENYLPYROPHOSPHATE.

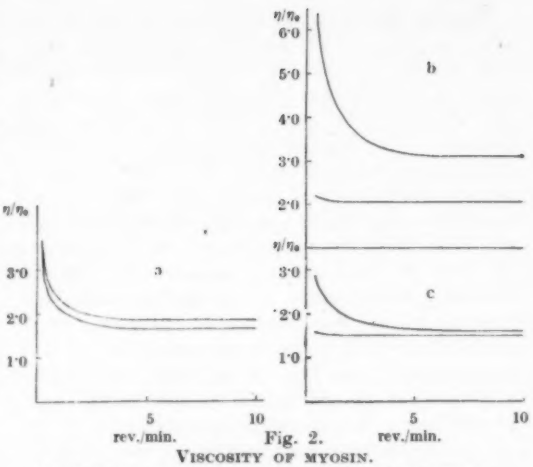


Fig. 2. VISCOSITY OF MYOSIN.

(*a*) EFFECT OF POTASSIUM ADENYLPYROPHOSPHATE; (*b*) INCREASE OF ANOMALOUS VISCOSITY IN A DILUTE BIREFRINGENT MYOSIN KCl SOL HELD AT 37° C. FOR 2 HR.; (*c*) RESTORATION OF ANOMALOUS VISCOSITY TO A NON-BIREFRINGENT MYOSIN KCl SOL BY TREATMENT AT 37° C. FOR 2 HR.

the sol returning to approximately its original birefringence intensity, and then remaining there for some hours, only in the end to rise. In such circumstances, the parallel increases in relative viscosity and viscous anomaly are also inhibited. This effect on the particle shape recalls the protective effect of adenylpyrophosphate on the enzymic activity itself at 37° C. discovered by Engelhardt and Ljubimova[8], and confirmed by us.

The reversibility of the change in flow birefringence intensity of myosin is of much interest, since according to Edsall and Mehl[11], no treatment has ever hitherto been found to restore flow birefringence when this property has once been lost. We find, however, that adenylpyrophosphate is not unique in causing a reversible fall in flow birefringence intensity. After the flow birefringence has been reduced or abolished by ions such as Li', Ca'', Mg'', or NH_4', or by urea, all that is required to restore it is a short period at physiological temperature (or under some conditions even at room temperature), and its original value is reached long before any signs of gelation appear. It is even possible in this way to restore flow birefringence to a myosin sol which on long standing at 0° C. has lost the property. During such a restoration, or during the rise of birefringence from its original value in, for example, a 0·5 *M* KCl myosin sol subjected to 37° C., relative viscosity increases and flow anomaly appears, first slightly, then markedly (see Fig. 2 *b*, *c*). The particles must therefore become very much longer.*

*The restored flow birefringence intensity cannot be ascribed to the photo-elastic effect in a gel under strain because (a) anomalous viscosity appears before the relative viscosity has much increased, and (b) the angle of isocline remains about 70° showing that the particles are orienting freely.

Thus the physiological significance of the adenylpyrophosphate effect, which might at first sight seem to be lessened by experiments on simple salts, regains its force in that these themselves give reversible changes in flow birefringence and viscosity, which should throw light on the reversible changes in the intact muscle cell. One cannot, of course, compare too closely the behaviour of myosin in the muscle cell and myosin isolated in the form of a sol. In the muscle the contracting particles do work against resistance; in the sol this does not happen. It should be made clear, however, that potassium adenylpyrophosphate is more effective in causing immediate fall of flow birefringence than any of the other salts so far studied, 1–2 *M* concentrations not being nearly as effective as 0·1 *M* adenylpyrophosphate. None of the effects here described can be due to differences in the refractive index of the dispersion media used, since these are very small (within the limits 1·3336–1·3437). What connexion the reversible changes in flow birefringence here described have with those occurring in the birefringence of the intact muscle fibre remains to be determined. It is known from older work, put on a firm basis by v. Muralt[13] in 1932, that during a single isometric twitch the birefringence decreases by some 35 per cent, returning to its original value by the end of relaxation. It has also been found by Buchtal and Knappeis[14] that in the absence of contraction, changes in hydrogen ion concentration and salt concentration in the medium surrounding a contractile isolated muscle fibre bring about slower reversible changes in its birefringence. We doubt if there is much to be gained by referring to the myosin sol after its birefringence has fallen and it has begun to dephosphorylate adenylpyrophosphate as 'denatured', unless we are careful to say that the 'denaturation' (which involves neither changes of solubility, nor, as has been shown by Greenstein and Edsall[15] in the case of the salt effects, changes in titratable –SH linkages) has not gone beyond an early reversible stage at which it is compatible with active enzymic breakdown of the adenylpyrophosphate.

How exactly the adenylpyrophosphate interacts with the myosin in normal muscle remains unclear. But there is a suggestion in the facts already known (entertained for some time past by one of us (D. M. N.) and now put forward in a rather different form by Kalckar)[16] that myosin might be phosphorylated and dephosphorylated, occupying thus the last link in the chain of simultaneous transfers of phosphate ions and energy. As is well known, adenosinediphosphate can be phosphorylated according to circumstances by creatinephosphate, phosphopyruvic acid, or diphosphoglyceric acid. We suggest that while it acts as a phosphate acceptor towards these substances, adenosinetriphosphate (adenylpyrophosphate) acts as a phosphate donator towards the contractile protein itself. Contracted myosin would thus have adenylpyrophosphatase activity and phosphate would be transferred from the adenylpyrophosphate to some part of the protein molecule, which would simultaneously extend. Extended myosin would then be in phosphorylated form and charged with energy. When the physical changes touched off by the nerve stimulus occur, inorganic phosphate would be set free, and the energy available from this dephosphorylation used in contraction. It might even be, in view of the effects described in this note, that the contraction of the particles in the fibril would be occasioned by a sudden contact (brought about by changed permeability) with the resynthesized adenylpyrophosphate, the substrate, itself. Such possibilities obviously invite further study.

These experiments, which indicate that adenylpyrophosphate has a direct influence on the relative optical anisometry and on the shape of myosin particles, and possibly on their intermicellar forces, will be continued and extended as better optical and other apparatus becomes available.* They form part of a general investigation of the shape of protein particles arising out of an interest in the proteins of developing embryonic cells. Although they primarily concern the connexion between energy-transfer and myosin-fibril contraction, they are perhaps not without a relevance to inductor-reactor systems in embryos undergoing morphogenesis. The possibility should now be borne in mind that an inductor might be, not a co-enzyme or an auto-catalytically active protein, but a substrate, and that the changes in protein configuration which will lead to a specific histogenesis might be the result of the unavoidable action of an enzyme protein in the competent cell upon the inductor itself.

* The authors wish to take this opportunity of thanking Prof. J. D. Bernal and Dr. J. F. Danielli for the stimulus and benefits of their conversation, and Prof. Tilley for the loan of valuable apparatus.

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OBITUARIES

Prof. A. Lapworth, F.R.S.

As a professor of chemistry, Arthur Lapworth will be remembered for his distinguished pioneer work on the mechanism of organic reactions and the reactivity of organic compounds, which was recognized in the award of the Davy Medal of the Royal Society. His colleagues in the University of Manchester and his many other friends will also remember, with gratitude and affection, such characteristics as his devotion to the maintenance of high intellectual standards in the University, his encouragement of co-operation between workers in different branches of science, his lively and expert interest in half a dozen fields outside his scientific work, and his sensitive sincerity and modesty.

After graduating at Mason College, later the University of Birmingham, where his father had become the first professor of geology, Lapworth began his research career in H. E. Armstrong's department at the City and Guilds Institute, South Kensington. The careful study of the sulphonation of the ethers of β-naphthol, for which he obtained his London D.Sc. in 1895 at the age of twenty-three, laid a foundation for his interest in aromatic substitution and isomeric change. With F. S. Kipping as senior collaborator he entered the terpene field with studies of bromocamphors and camphorsulphonic acids. Later, as lecturer in chemistry at the School of Pharmacy, Bloomsbury, he extended this work independently to the extent of some twenty papers, making particularly important contributions to the clearing up of the tangle of the monocarboxylic acids derived from camphoric acid. His report on the constitution of camphor, published by the British Association in 1900, is regarded as a classic.

Parallel with this work and later, when Lapworth had become head of the Chemistry Department at the Goldsmiths' Institute, he developed his characteristic contribution to the study of organic reactions. His attack on this problem shows two interacting aspects. On one hand he carried out fundamental investigations of the kinetics of a variety of organic reactions, which provided him with chosen foundations for theoretical discussion and many workers with a basis for extensive studies of further detail. On the other hand, he was always seeking generalizations concerning reactants and reactions which would be more comprehensive than the very limited analogies which were the stock in trade of organic chemists. He saw that very ambitious speculations would get lost in the bewildering mass of data concerning the behaviour of carbon compounds, but that progress could best be made in stages by accounting for well-chosen groups of related phenomena. Generalizations such as he put forward are necessarily open to a variety of criticisms, and it was only when, in the fullness of time, they were seen to build into wider theoretical conceptions, that the extraordinary soundness of Lapworth's insight gained full recognition. He combined what sometimes seemed almost artistic convictions about the significance of particular analogies and conceptions, with precision of thought in stating and applying them. Unfortunately, some of his critics skimmed over the outlines of his ideas, and on applying their impressions met with inevitable disappointments.

Lapworth's recognition in 1898 of the generality of isomeric changes of the form

$$M-R_\alpha-R_\beta=R_\gamma \rightleftarrows R_\alpha=R_\beta-R_\gamma-M$$

led to his discovery that the γ-position in crotonic ester shows reactivity similar of that characteristic of the α-position in saturated esters. He first established essential features of cyanohydrin formation by a typically simple colorimetric method using yellow camphor-quinone, and from this beginning he developed comparisons of the properties of the carbonyl group and of the ethylene bond in αβ-unsaturated carbonyl compounds. He also formulated the accepted mechanism of the benzoin condensation. His interest in the relation between tautomeric change and aromatic and aliphatic substitution led to fundamental experiments on the halogenation of acetone and of carboxylic acids. The study of the effect of acids on enolization, and hence on halogenation, was followed by physico-chemical investigations on the catalytic activity of hydrogen ions, including consideration of the effect of adding water to acids in organic solvents. In 1909, at an early stage of this work, Lapworth was appointed senior lecturer in inorganic and physical chemistry and assistant director of the Inorganic Chemical Laboratories in the University of Manchester. His continuation of the work on ionization, together with lecturing requirements, gave him a grasp of thermodynamics which was an important element in his later thought.

Turning again to organic chemistry, Lapworth established a number of properties of sulphonic esters, contrasting their tendency to detachment of the alkyl group with that of carboxylic esters to reactions involving detachment of alkoxyl. In 1913 he was elected to the Royal Society and appointed to succeed W. H. Perkin, junior, as professor of organic chemistry in Manchester. The war of 1914–18 soon interrupted publications, except for a small group on the constituents of brain tissue and the pungent principles of ginger.

In 1920 Lapworth published his principle of alternate polarities. In this he focused attention on the polar properties induced in aliphatic and aromatic compounds by substitution, as shown by the study of the characteristic activity of the various atoms in molecules of both types. He also emphasized how unsatisfactory were the terms 'electronegative' and 'electropositive' as applied to groupings in organic molecules, and stressed the significance of the classification of groups according to their general influence on acidic or basic properties of compounds. He

developed these views later, based successful experiments on them and, partly by his publications such as those in 1922 but also by personal discussions, he helped in laying the foundations on which Robinson based a more general and clearer interpretation of these phenomena in electronic terms. Most valuable was his classification of reactants in organic reactions as anionoid and cationoid (1925), which fused conceptions of organic reactivity with those by which acids and oxidizing agents are recognized as electron acceptors, and bases and reducing agents as electron donors. The condensed nature of this publication and the renaming of these classes by Ingold eight years later should not obscure the fundamental nature of Lapworth's contribution.

Among his work on the subsequent developments of electronic conceptions one may notice particularly the recognition, in 1928, that the effect which was afterwards given a physical interpretation as resonance must be regarded as affecting the average molecules of the reactants, and that the polarizability of molecules was not an adequate explanation. These theoretical extensions were made in discussing further experimental studies of the cyanohydrin and other reactions.

In all this original work Lapworth's theoretical insight and his skill with simple experimental methods were combined with an extraordinary grasp of general chemistry. It was therefore natural that as a teacher, lecturing on physical, organic and general inorganic chemistry in succession, he should concern himself to an unusual degree with the exposition of ideas, methods and general principles, so that his lectures were most stimulating and valuable to his better students, though they might be the despair of some who wanted only the easy catalogue of information.

By taste and temperament Lapworth was a scholar and investigator rather than an administrator, but he was called to be director of the Chemistry Laboratories at Manchester for a dozen years. Throughout this period he had invaluable help from his wife in handling departmental details, and his own qualities brought to him the affection and full support of his colleagues. The first half of his period as director saw the fruitful collaboration between himself and Prof. (now Sir Robert) Robinson, whom the University was able to invite to become professor of organic chemistry in 1922 through Lapworth's ability to transfer from that chair to the inorganic and physical side. When Robinson went to London in 1928, Lapworth made his objective the development of the school of physical chemistry in Manchester to full stature, through the appointment of a professor of established reputation to a new chair in that branch of chemistry, while maintaining the traditional strength of the organic side of the department. During the five years which, as it transpired, were necessary to achieve this, he was responsible for the whole department and, with characteristic sacrifice of personal and temporary interests, he considered it necessary to maintain it on the most economical basis to provide for the maximum expansion of equipment and opportunity when he would be handing over. It will generally be agreed that with the appointments of Prof. I. M. Heilbron and Prof. M. Polanyi the object which he set himself, and which the University adopted, was fully achieved. But for the present war it would have been rounded off by a new building for physical chemistry, in addition to the re-equipping of the existing laboratories which his successors carried out.

After the severe strain of these years of responsibility, Lapworth's health, which was never robust, broke down, but a period of rest and care enabled him to enjoy again the visits of his friends and some of the many hobbies and recreations which he had cultivated with remarkable skill and thoroughness. Music had run through his whole life. He had represented the University on the council of the Royal Manchester College of Music for more than twenty years. His taste was thoroughly sound, and he played the violin well and with great enjoyment. At his house one might have chamber music, or talk of fishing or of the arrival of migrant birds on an Easter holiday, or perhaps an exposition of microscopy or a wireless speciality, or reminiscences of mountaineering, or news of the latest from the theatre or the films—indeed the most diverse interests and lively comment. Many of his friends will retain pleasant memories of these occasions.

G. N. BURKHARDT.

Dr. R. T. Beatty

DR. RICHARD THOMAS BEATTY, whose death was announced recently, was a member of the Admiralty Scientific Staff and was born at Dungannon on April 26, 1882. He was educated at the Royal School, Dungannon, and Queen's University, Belfast, where he afterwards became lecturer in experimental physics.

Beatty worked for some years at the Cavendish Laboratory where he became interested in what were then known as homogeneous or characteristic X-rays. He was exciting this radiation and the associated secondary electrons and making a number of pioneer observations in this field. These observations were among those which helped to lay the experimental foundations of the quantum idea which was only then beginning to take shape. Between 1907 and 1920 he published a number of papers, mainly in the *Philosophical Magazine* and the *Proceedings of the Royal Society*, on this and related subjects.

Beatty served at the Admiralty in a temporary capacity in the War of 1914–18, and was engaged in research work at Portsmouth. In 1920 he joined the permanent scientific staff of the Admiralty.

WE regret to announce the following deaths :

Squadron-Leader J. O. Hinks, formerly Armourers and Brasiers' research fellow in aeronautics at Cambridge, on active service, aged twenty-nine.

Prof. W. Vogt, professor of anatomy in the University of Munich, noted for his work on the embryology of the Amphibia, on March 17.

NEWS AND VIEWS

The King's Birthday Honours

THE following names of scientific men and others associated with scientific work appear in the King's Birthday Honours List:

Baron: Prof. F. A. Lindemann, personal assistant to the Prime Minister, professor of experimental philosophy, Oxford.

G.B.E.: Viscount Nuffield.

K.C.B.: Sir George Gater, permanent Under-Secretary of State for the Colonies and secretary, Ministry of Home Security, formerly clerk and education officer to the London County Council.

K.C.M.G.: Mr. Frank Gill, for services in development of the telephone industry and of international telephony; Dr. H. H. Scott, director of the Bureau of Hygiene and Tropical Diseases, London.

Knights Bachelor: Col. A. S. Angwin, Engineer-in-Chief, General Post Office; Mr. R. W. Gillespie, a founder of the Fairbridge Farm Schools in Australia; Prof. J. P. V. Madsen, professor of electrical engineering, University of Sydney, and chairman of the Radio Research Board, Australia; Dr. P. H. Manson-Bahr, for services to tropical medicine and as consulting physician to the Colonial Office; Mr. K. G. Mitchell, consulting engineer (roads), India; Mr. E. B. Pratt, managing director, Imperial Chemical Industries (India), Ltd.; Prof. J. B. S. Stopford, vice-chancellor, University of Manchester.

C.B.: Mr. C. A. Taylor, regional director, London Telecommunications, General Post Office; Mr. F. A. Whitaker, civil engineer in chief, Admiralty.

C.M.G.: The Hon. F. E. Harris, Minister of Agriculture and Lands, Minister of Supply, Industry, and Post-war Development, Southern Rhodesia; Dr. S. A. Neave, assistant director, Imperial Institute of Entomology; Dr. H. A. Tempany, agricultural adviser to the Secretary of State for the Colonies.

C.I.E.: Mr. W. Meiklejohn, senior conservator of forests, Bengal; Mr. C. F. C. Beeson, forest entomologist and conservator, Government of India.

C.B.E.: Prof. F. C. Bartlett, professor of experimental psychology in the University of Cambridge, and a member of the Flying Personnel Research Committee; Maj. G. P. Bulman, director of engine development and production, Ministry of Aircraft Production; Mr. W. Deacon, president of the Pharmaceutical Society of Great Britain; Mr. W. A. Elder, principal veterinary and agricultural officer, Swaziland; Mr. R. H. Franklin, assistant secretary, Ministry of Agriculture and Fisheries; Dr. J. A. Glover, lately senior medical officer, Board of Education; Mr. P. Good, deputy director, British Standards Institution; Mr. M. T. Tudsbery, civil engineer to the British Broadcasting Corporation; Dr. R. Wilson, Commonwealth statistician and economic adviser to the Treasury, Australia.

O.B.E.: Prof. J. F. Baker, professor of civil engineering, University of Bristol, and scientific adviser, Research and Experiments Branch, Ministry of Home Security; Lieut.-Col. T. H. Battye, director of statistics, Department of Supply, India; Mr. T. Beacall, an assistant comptroller, Patent Office; Dr. R. C. Bowden, assistant director, Ordnance Factories, Ministry of Supply; Prof. T. H. Davey, director, Sir Alfred Lewis Jones Research Laboratory, Sierra Leone; Dr. A. G. Francis, deputy Government chemist; Mr. E. E. L. Grundy, Principal, Technical School, Jamalpur; Mr. J. B. Nevitt, general manager, Ammunition Dept., Imperial Chemical Industry (Metals), Limited; Dr. S. J. Saint, director of agriculture, Barbados; Maj. L. Sealey-King, district officer, Nigeria; Khan Bahadur Maulvi Zafar Hasan, lately Superintendent, Archæological Survey, Northern Circle, Agra.

M.B.E.: Lala Kundan Lal Aggarwal, deputy conservator of forests, Punjab; Mr. L. C. Giles, assistant district officer, Nigeria; Mr. P. W. Harris, district officer, Kenya; Mr. J. T. Kennedy, senior assistant livestock officer, Uganda; Mr. P. E. Keam, Council for Scientific and Industrial Research, Australia; Sohan Lal, principal, School of Engineering, Orissa; Mr. K. W. Switzer, district officer, Nyasaland.

I.S.O.: Mr. J. L. Oliver, lately a native commissioner, Southern Rhodesia; Lieut.-Colonel F. J. Wane, for services as a native commissioner in Southern Rhodesia; Mr. S. B. Williams, district commissioner, Swaziland; Mr. S. B. Brewer, head of the Technical School Section, Board of Education; Mr. H. Chambers, principal, Ministry of Agriculture and Fisheries; Mr. J. Getty, chief inspector, Ministry of Agriculture, Northern Ireland.

On the outbreak of war, it was obvious that restrictions would have to be imposed on the use of paper. By adopting a slightly thinner paper, and the curtailment or omission of certain sections of NATURE, it has been possible to retain its more important features. Further reductions in size are now being imposed, but every effort will be made to ensure that no vital characteristic of the journal is impaired.

The publishers regret to have to announce that, on account of increased costs, the price of NATURE as from and including the issue of July 5 will be 1*s.* 6*d.*

Prof. F. A. Lindemann, F.R.S.

ALL who know Prof. F. A. Lindemann, professor of experimental philosophy in the University of Oxford, will be glad that the King has conferred the honour of a barony on him. Prof. Lindemann is one of the few men of science to rise to a position of influence in affairs in our time and quite possibly the youngest man of science ever to be elevated to the House of Lords. Those who profess to see in him merely "the man of mystery behind Churchill" or who laud him as the inventor of everything or depreciate him as the thwarter of all good schemes, do injustice to a man of great personality and remarkable parts. At the Prime Minister's right hand he is peculiarly well placed. His foresight, his wide knowledge of the scientific problems that the age and the War have brought forth, his great ingenuity, never more acutely shown than when difficulties are greatest, and his abundant courage, are, perhaps, his most serviceable qualities. There is one other quality, however, of great importance. Prof. Lindemann has a knowledge of the mentality of the French and Germans (he was educated at Darmstadt, Berlin and Paris) which few of the Government advisers could have and more 'realistic' than official advisers or diplomats seem to have had. This Continental experience of his, no less than his scientific insight and personal gifts, should stand him in good stead as a member of the Upper House, and in his present responsible position.

The Right Hon. Winston Churchill, F.R.S.

A UNIQUE ceremony took place in the Cabinet Room at 10 Downing Street on June 12, when the President of the Royal Society, Sir Henry Dale, admitted the Prime Minister into the fellowship of the Society. Among those present were the Society's biological secretary, Prof. A. V. Hill, M.P., the physical secretary, Prof. A. C. G. Egerton, the foreign secretary, Sir Henry Tizard, and the assistant secretary, Mr. John D. Griffith Davies. After the Prime Minister had signed his name in the ancient Charter Book, Sir Henry Dale showed him the signature of his ancestor, Sir Winston Churchill, father of the great Duke of Marlborough, who was one of the early fellows of the Society, having been admitted into the fellowship in 1664.

The Union Observatory, Johannesburg

THE Union Astronomer, Dr. H. E. Wood, director of the Union Observatory, Johannesburg, retired on February 3. Dr. Wood, who was educated at the University of Manchester, was appointed assistant at the Transvaal Observatory, under the directorship of the late Dr. R. T. A. Innes in 1908. The work of that Observatory had been largely meteorological, of a routine nature, but after the appointment of Dr. Innes as director, the astronomical work was developed, new instrumental equipment was obtained and the Observatory—the name of which was changed to the Union Observatory in 1912—became one of the most important in the southern hemisphere. Dr. Wood succeeded Dr. Innes as Union Astronomer, on the latter's retirement in 1927. He has been particularly interested in the observation of minor planets and comets; he discovered many new minor planets and computed many orbits of minor planets and comets. Dr. Wood has also been an assiduous observer of occultations of stars by the moon, and the large number of occultations observed at the Union Observatory for many years has been of the greatest value in the study of the moon's motion. Dr. Wood has been closely associated with the South African Association for the Advancement of Science, of which he was for many years one of the secretaries and of which he was president in 1931.

Dr. H. E. Wood has been succeeded as Union Astronomer by Dr. van den Bos, who started his astronomical career as an assistant at the Leyden Observatory. A scheme of co-operation between the Union Observatory and the Leyden Observatory had been arranged, under which the Leyden Observatory—which has a large staff but poor observing conditions—should station one member of its staff at the Union Observatory—which has a small staff but good observing conditions—to whom all necessary facilities should be offered. Under this scheme Dr. van den Bos, whose primary interest is double star observation, went to Johannesburg in 1926 to make observations of double stars with the large 26½-in. visual refractor. In 1927 he was transferred to the staff of the Union Observatory, becoming chief assistant in succession to Dr. Wood, on his appointment as Union Astronomer. Dr. van den Bos is not only an assiduous and accurate double-star observer but has also computed many double star orbits. With the collaboration between Dr. van den Bos and Mr. Finsen, one of his assistants, the Union Observatory is now making a more important contribution than any other observatory to double star astronomy. Among interesting observations made by Dr. van den Bos and Mr. Finsen have been the apparent triplicity of Nova Pictoris, a few years after its outburst, the three nuclei showing a progressively increasing separation; also the figure-of-eight appearance of the asteroid Eros at the 1931 opposition, which rotated in the period of the variation of brightness of Eros.

U.S. National Academy of Sciences: Recent Elections

AT the annual meeting of the U.S. National Academy of Sciences, recently held at Washington, the following were elected foreign associates: Prof. E. D. Adrian, professor of physiology in the University of Cambridge; Prof. A. V. Hill, secretary of the Royal Society and Foulerton research professor (NATURE, May 10, p. 573); Sir Arthur Keith, formerly Hunterian professor of the Royal College of Surgeons (NATURE, May 24, p. 639).

The following American men of science were elected to membership: Prof. W. E. Bachmann, associate professor of chemistry in the University of Michigan; Dr. R. J. Dubos, associate in bacteriology in the Rockefeller Institute for Medical Research; Prof. E. A. Graham, professor of medicine in Washington University (St. Louis); Dr. A. S. King, superintendent of the physical laboratory, Mount

Wilson Observatory; Prof. C. C. Lauritsen, professor of physics in the California Institute of Technology; Dr. A. L. Loomis, director of the Loomis Laboratories, Tuxedo Park, N.Y. (physics); Prof. J. R. Oppenheimer, professor of physics in the University of California; Prof. J. T. Patterson, director of zoological research in the University of Texas; Prof. Karl Sax, professor of botany in Harvard University; Dr. G. G. Simpson, associate curator of vetebrate palæontology in the American Museum of Natural History; Dr. Joseph Slepian, Westinghouse Electric and Manufacturing Company (electrical engineering); Dr. L. F. Small, National Institute of Health (organic chemistry); Dr. W. M. Stanley, associate member in biophysics of the Rockefeller Institute for Medical Research; Prof. T. Y. Thomas, professor of mathematics in the University of California at Los Angeles; Prof. G. B. Wislocki, Parkman professor of anatomy in Harvard University.

University College, Nottingham: Air-Raid Damage

NOTTINGHAM University College buildings in Shakespeare Street have been damaged by a high explosive bomb of heavy calibre. The Departments of Mining and Textiles occupy the Shakespeare Street buildings. The Faculties of Arts and Pure Science and the Departments of Engineering are housed in University Park buildings. The main damage was confined to the west wing of the building, the principal lecture theatres and laboratories, though seriously damaged, escaping destruction. The Mining and Fuels Department was almost completely destroyed, including practically the whole of its valuable apparatus.

In the Textiles Department, which was housed in that section of the building formerly occupied by the Natural History Museum until it was transferred to Wollaton Hall, some of the hosiery machinery was salvaged, but much damage was done to the general structure of that part of the building. Blast broke windows, removed doors and blew down plaster, etc., in practically all parts of the building.

German Aircraft Design

TECHNICAL details now available of the new German fighter, Messerschmitt 109*F*, indicate the general trend of enemy aircraft design towards high altitude operation. The machine, a modification of earlier Messerschmitt fighters, is clearly designed not only to reach great heights, but also to retain climb and general manœuvrability at those altitudes, without which the operation of air fighting is at a tactical disadvantage. It is claimed that this design has a service ceiling of 38,000 ft., but the attainment of this height alone has little advantage, it being necessary to retain a speed of manœuvre better than the opposing aircraft, for fighting purposes.

The wing area has been increased, an alteration necessary for this effect, but disadvantageous in many other respects. The amount of armament has been decreased to one cannon and two machine guns. Weight reduction is also an advantage for high altitude work, but a lessening of fire power has obvious drawbacks in a fighter. All guns are now enclosed in the body, the outboard ones on the wings being discarded. The concentration of weight nearer the centre of the machine would improve the quickness of the response to lateral control. Possibly it also reduces the weight and complication of the arrangement for heating the guns, as they would be nearer to the engine, the most convenient source of heat available. It is essential in high altitude flying to prevent freezing up of guns, while they are not in action, by some externally applied heat.

Engineering Economy and Æsthetics

THE Council of the Institution of Civil Engineers has recently given consideration to the need to foster among engineers the closer study of: (*a*) the economics of engineering projects; (*b*) the organization and management of engineering work; and (*c*) the relations of æsthetic considerations to engineering design and construction. It is believed that in the period of reconstruction and development which will follow the War these subjects will become of increasing importance, and in the national interest should form a part of the equipment with which engineers should be furnished in order that they may adequately play their part in the task before them. The Council accordingly intends to examine all possible means by which the Institution can influence the better understanding of engineering economics and æsthetics, not only by students resident at the universities, but also by those otherwise engaged in their engineering training, so that eventually a study of these subjects may form an integral part in the recognized education of all engineers.

As a beginning, the Council of the Institution approached the University of Cambridge with an offer to finance for a period of five years a lectureship on the subjects envisaged in the hope that they would in due course form part of the engineering curriculum of the Mechanical Sciences Tripos. The proposal was cordially welcomed, and has now been accepted in principle by the Council of the Senate of the University; but its full adoption will necessitate some reconsideration of the scheme of instruction in the Engineering School and possibly of the Mechanical Sciences Tripos, which it would be impracticable to undertake in war-time. Nevertheless, during the next academical year, a number of eminent engineers and others will be invited to visit the University to give either single lectures or short courses on subjects coming within the terms of the proposal.

Foreign Periodicals in War-time

THE Association of Special Libraries and Information Bureaux is undertaking a survey in Great Britain of the present position in regard particularly to enemy and enemy-controlled publications, especially the current issues of periodicals. Previous explanatory surveys have confirmed the impression that since the early part of 1940 only very limited supplies of such publications have been arriving in Great Britain; that they consist mainly of imperfect sets of a relatively few periodicals restricted very largely to departmental libraries that are not accessible to the general public; and that there is

widespread dissatisfaction and a sense of frustration among students and intellectual workers generally as well as among research workers and technologists intimately associated with the war effort. Nothing short of a fully representative, detailed and documented survey can reveal the inadequacy of the present supplies. Through the good offices of the Royal Society, the Rockefeller Foundation has provided funds for the conduct of a rapid, extensive survey of this character.

The survey will be made by a Committee of the Association and will be completed by the autumn. A memorandum is being circulated to some two thousand institutions and individuals to ascertain what publications they need and the extent to which they are locally available. In the interim, endeavours will be made to facilitate the distribution of available supplies, but the primary objective is to obtain a detailed inventory of needs and to ascertain what further supplies are essential to meet demands. Those interested should communicate with the A S L I B Foreign Periodicals Committee, 31 Museum Street, London, W.C.1.

Medicinal Herbs

THE Committee recently appointed by the Ministry of Health to consider what steps should be taken to secure organization of cultivation and collection of vegetable drugs has presented an interim report. The committee, of which the chairman is Sir Weldon Dalrymple-Champneys, considers that, so far as domestic production is concerned, attention should be concentrated on the following: Agar, dill, belladonna, Irish moss, colchicum, digitalis, ergot, male fern, liquorice, henbane, peppermint, psyllium, sphagnum, stramonium, dandelion and valerian. The committee is thus in agreement with the recommendations of the Medical Research Council, which advised, in M.R.C. War Memorandum No. 3, that all these drugs, with the exception of agar, should be produced in the United Kingdom; with regard to agar, the M.R.C. Memorandum recommended that its production should be encouraged in the British Empire overseas. Concerning the collection of herbs which grow wild, the report of the committee of the Ministry of Health states that steps have already been taken to encourage it on methodical lines, and commends the efforts of the Boy Scouts Association in this direction; the Association has circulated a pamphlet giving details of identification, methods of collecting, drying and dispatch, in respect of several vegetable drugs and has arranged that the trade will purchase the collections so made. The Royal Botanic Gardens, Kew, have conferred with the National Association of Women's Institutes to organize the collection of important herbs in each county, the selection of the herbs to be determined by their local abundance.

State Laboratory of Eire

THE report of the State Chemist of Eire upon the work of the State Laboratory for the year ending March 31, 1941, has been issued in typescript form. The Laboratory carries out chemical work for all departments of the Government of Eire, the greater portion being performed in the Laboratory in Upper Merrion Street, Dublin, but samples of wines, spirits and tea are also examined at the chemical station in the Custom House, Cork. The total number of samples examined in the course of the year, including those dealt with at Cork, was 29,571, as compared with 37,843 in the preceding year, a decrease of 8,272. Of this figure, 531 samples represent the decrease at Cork Chemical Station. The decrease in the number of samples examined was mainly in respect of those received for the Revenue Commissioners and the Department of Agriculture and Fisheries. There was a large fall in customs import samples, particularly in regard to wines and spirits; the fall in the number of samples received from the Department of Agriculture and Fisheries was due to the impossibility of obtaining dairy instruments from the Continent and the cessation of sea water sampling. Increases were registered in respect of 'wrecked goods', and additional samples of feeding stuffs were examined in order to control any possibility of adulteration due to shortage in supplies. The development of the Milk and Dairies (Special Designations) Regulations led to an increased number of tests being carried out for the Department of Local Government and Public Health. The introduction of the phosphatase test has enabled close control of pasteurization to be achieved; investigation of plants yielding milk failing on this test has always revealed defects corresponding to the result of the test. A variety of specimens has been examined for the Department of Justice during the year.

Trichinosis in Britain

AT a meeting of the Section of Epidemiology and State Medicine of the Royal Society of Medicine on May 22, Dr. P. B. Beeson, of Harvard University, read a paper on factors influencing the prevalence of trichinosis in man. He said that few cases of trichinosis have been recognized in Great Britain until recently, although the disease occurs fairly commonly in Europe and the United States. Within the past few months, however, several outbreaks have been reported in different parts of England and Wales, which have evoked a new interest in the clinical and epidemiological aspects of the disease. Since human trichinosis is nearly always acquired by eating pork, knowledge of the ways in which swine become infested is important. In the United States, where 0·5–5·0 per cent of swine has trichinosis, the chief factor responsible is the practice of feeding swine on uncooked garbage. In Great Britain there is little opportunity for this means of swine infestation to take place, and the probability is that the rare cases of swine trichinosis which occur in this country are acquired by eating infested rats. Trichinosis has been found in rats in several parts of Great Britain.

Locally manufactured sausages appeared to have been the meat responsible for the recent epidemics of human trichinosis in Great Britain. In explanation of the large number of people involved in some of

these epidemics, it was pointed out that rationing of meat and changes in the composition of sausages have brought about a condition whereby an unusually large number of people eat the meat of a single animal. Furthermore, in view of the fact that a partially protective immunity develops after one attack of trichinosis, comparative susceptibility of the British population might have led to the development of more clinical cases than would have resulted from similar exposure of a previously exposed population. The measures indicated for prevention of the disease are destruction of rats and education of the public about the danger of eating raw or undercooked pork.

Announcements

SIR D'ARCY THOMPSON, professor of natural history in the University of St. Andrews, has been elected a member of the American Philosophical Society.

PROF. R. W. WOOD, research professor of experimental physics in Johns Hopkins University, has been awarded the Henry Draper Medal of the U.S. National Academy of Sciences "in recognition of his contributions to astronomical physics".

DR. MAX NONNE, professor of neurology at the University of Hamburg, has recently been awarded the Goethe Medal for Art and Science on the occasion of his eightieth birthday.

PROF. OTTO HAHN, director of the Kaiser Wilhelm Institute for Chemistry, Berlin-Dahlem, has been awarded the Copernicus prize for 1941, by the University of Königsberg for his work on radioactivity.

PROF. JACQUES ERRERA, formerly professor of physical chemistry in the University of Brussels, has been appointed manager of the Research and Control Division of Sidney Blumenthal and Company at Shelton, Conn.

MISS J. P. STRACHEY will retire shortly from the principalship of Newnham College, Cambridge, which she has held since 1923, and the fellows of the College have elected as her successor Miss Myra Curtis, associate and fellow of the College and principal assistant secretary to the War Damage Commission.

THE late Sir Charles Clifford by his will left a share of his residuary estate to the University of Sheffield. Since the death of Lady Clifford on May 1, the residuary estate falls to be divided between the beneficiaries. It is expected that the University will receive upwards of £50,000, after duties have been paid.

The following appointments have recently been made: Dr. V. M. Conway, assistant lecturer; Dr. L. Leyton and Mr. A. N. Barker, temporary demonstrators; Mrs. E. M. Harrison, part-time assistant in the Department of Botany.

AT the annual general meeting of the Institute of Physics held on June 4, the following were elected to take office on October 1, 1941: *President*, Sir Lawrence Bragg; *Vice-President*, Prof. W. Makower; *Honorary Treasurer*, Major C. E. S. Phillips; *Honorary Secretary*, Prof. J. A. Crowther; *Ordinary Members of the Board*, Prof. J. Chadwick and Mr. D. C. Gall.

AT the annual general meeting of the Marine Biological Association of the United Kingdom, Dr. George Parker Bidder was re-elected president. The list of officers and vice-presidents also remains unchanged. As new members of Council, Dr. C. F. A. Pantin, Prof. T. A. Stephenson, Prof. W. M. Tattersall, Prof. C. M. Yonge and Mr. J. Z. Young were elected.

MR. R. S. HUDSON, Minister of Agriculture, has announced the appointment of an Agricultural Improvement Council for England and Wales, to devise methods for seeing that promising results of research are brought as rapidly as possible into ordinary farming practice. The Council will advise from time to time on agricultural problems that seem to need scientific investigation. It will consist of a chairman and twelve members, appointed for three years with the possibility of re-appointment, and will include practical farmers as well as distinguished men of science.

THE Bernard Baron Trustees have offered the Royal College of Surgeons £40,000 to endow a Bernard Baron research professorship at the College. In a letter making the offer, the Trustees state that they appreciate that a large part of the resources of the College will have to be devoted to the erection of new buildings and the assembling of new collections to replace the damage done to the College during air raids, and they have made the offer of a research professorship in order that research being carried out at the College may not suffer. The laboratories at the College provided by the Trustees fortunately have not been damaged structurally, and the valuable equipment they contained had been removed to improvised accommodation in the country.

A NINTH Summer Conference on Spectroscopy and its Applications will be held at the Massachusetts Institute of Technology during July 21–23. The conference will repeat to a considerable extent the type of programme presented at the conferences held during the past eight summers. The early sessions will be devoted principally to applications of spectroscopy to the analysis of materials. Other topics to be considered are absorption spectrophotometry, photographic photometry, biological and chemical effects of spectral radiation, industrial applications of spectroscopy, analysis of spectra and the measurement of wave-lengths. Further information can be obtained from Prof. G. R. Harrison, Massachusetts Institute of Technology, Cambridge, Massachusetts.

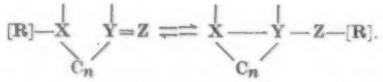
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

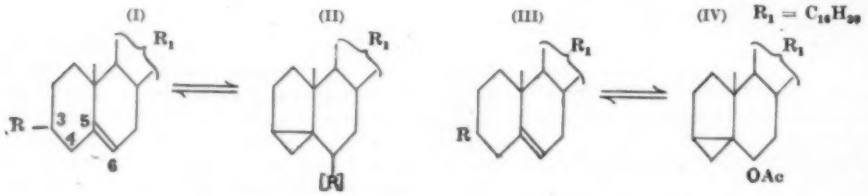
IN THE PRESENT CIRCUMSTANCES, PROOFS OF "LETTERS" WILL NOT BE SUBMITTED TO CORRESPONDENTS OUTSIDE GREAT BRITAIN.

Pentacyclic Steroids

THE arrangement of carbon atoms indicated by X, Y and Z in the following scheme is contained in many unsaturated steroids and constitutes a potential tautomeric system according to the general scheme



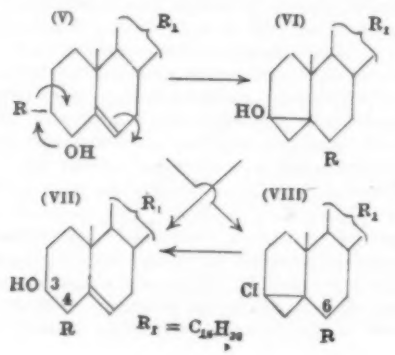
As the carbon atoms concerned (3, 5 and 6 in I) are components of a cyclic system, being members of ring A and B of the tetracyclic steroid ring system, the resulting tautomeric change would be a transannular one and involve the formation of a bridge-linkage from C_3 to C_5. Such an intramolecular rearrangement would therefore lead to a pentacyclic system as indicated in (II).



This transannular change has evidently occurred during the formation of *i*-cholesterol from cholesterol[1], for which so far no explanation has been offered: cholesteryl *p*-toluenesulphonate (III, R = *OTs*) is converted by an anionotropic change into *i*-cholesteryl acetate (IV). The reaction is reversible since cholesteryl acetate (III, R = *OAc*) is easily obtained from (IV).

In studying the puzzling reactions of the unsaturated α-glycol, *cis*-3 : 4-Δ^5-cholestene diol[2], we have now found that transannular rearrangements of the above type offer a rational interpretation of the observed facts. The two possible monoesters of the glycol have been obtained by various methods and the position of their esterified OH group has been established. The 3-monoesters (V, R = *OAc*, *OBz*, etc.) result *inter alia* from the action of acyl- or aryl-chlorides on the diol, whilst the 4-monoesters (VII) are smoothly formed at room temperature by the interaction of cholesteryl dibromide with the silver salts of the respective acids in pyridine solution as well as from cholesteryl esters and SeO_2 under well-defined conditions. The remarkable fact has also been established that an acyl migration from C_3 to C_4 occurs when the aliphatic 3-monoesters are warmed to 90° in acetic acid solution. This novel reaction, which has no analogy in the steroid series, becomes intelligible on the assumption of an intramolecular rearrangement and the intermediate formation of the labile pentacyclic compound (VI). Rupture of the bridge linkage, followed by the allylic change usual in these compounds then leads to VII.

The same mechanism accounts for the unexplained migration of a benzoyl group from C_3 to C_4 in the 3-benzoate of 6-chloro-Δ^4-cholestene[3]. This substance is obtained from the 3-monobenzoate of the *cis*-diol (V, R = *OBz*) by the action of $SOCl_2$ and, reacting in the tautomeric form (VIII, R = *OBz*) yields the 4-monobenzoate (VII, R = *OBz*) on replacement of Cl by OH.



An alternative mechanism of acyl migration, involving the formation of ortho carbonic esters as intermediates, will be discussed in the detailed account of this work.

Further, there is evidence in the literature of the sex hormones that pentacyclic steroids may occur as normal or pathological metabolic products of the animal organism. Two derivatives of this type, in the androstane and pregnane series respectively, are known as laboratory products[4]. The bridge-linkage in these substances is easily broken by contact with dilute HCl at room temperature. The resulting product in the androstane series is 3-chloro-dehydroandrosterone, a substance which has frequently been isolated from normal and pathological urines. In urine it originates obviously from a labile precursor, during the usual preliminary hydrolysis with dilute HCl in the isolation procedure. The ease of its formation seems to indicate this precursor to be a 6-monoester of *i*-dehydroandrosterone, which, owing

to its lability, has so far escaped isolation (cf. also 3:5-androstadienone[4] and other substances isolated from the urine of adrenal tumour cases[5]).

Experimental details of this work will be published elsewhere as soon as circumstances allow, in conjunction with Dr. V. A. Petrow and Mr. W. W. Starling. Work on analogous rearrangements in ring B of the steroids is in progress.

O. ROSENHEIM.

National Institute for Medical Research,
London, N.W.3. May 8.

[1] Wallis, Fernholz and Gephart, *J. Amer. Chem. Soc.*, **59**, 137 (1937); Beynon, Heilbron and Spring, *J. Chem. Soc.*, 1459 (1937).
[2] Rosenheim and Starling, *J. Chem. Soc.*, 377 (1937).
[3] Spring and Swain, NATURE, **146**, 718 (1940); *J. Chem. Soc.*, 83, (1941).
[4] Butenandt and Grosse, *Ber.*, **69**, 2776 (1936); **70**, 1446 (1937).
[5] Burrows, Cook, Roe and Warren, *Biochem. J.*, **31**, 950 (1937).
[6] Wolfe, Fieser and Friedgood, *J. Amer. Chem. Soc.*, **63**, 582 (1941).

Correlation between Sex-, Thyroid- and Adrenal Cortical Hormones

EXPERIMENTS were performed on 168 adult gonadectomized male and female rats. The following hormones were administered, the figures representing the dose given per week: androsterone 4·5 mgm., testosterone propionate 0·75 mgm., œstradiol benzoate-butyrate 0·015 and 0·09 mgm., desoxycorticosterone acetate 2–4 mgm. (also tablets of this hormone were implanted subcutaneously), desiccated thyroid powder 90–480 mgm., thyroxine sodium 1–3 mgm.

A co-operative stimulating effect on the weight and size of the organs was recorded between œstrogenic and thyroid hormones in the case of female sex organs, liver, kidneys and (less definitely) heart and spleen. Hypertrophy of the adrenals was also greater with these two hormones than with either hormone alone.

A similar stimulating co-operative effect was noticed between the male sex hormone androsterone and thyroid hormones in females, or desoxycorticosterone and thyroid hormones on the weight and size of liver, kidneys, heart and, less constantly, spleen, but not on sex organs.

Desoxycorticosterone, when injected alone, produced only a slight increase in weight of kidney and liver.

The following changes in weights of organs illustrate some of the above statements. In control ovariectomized rats' average weights were as follows: liver 7·22 gm., kidneys 1·53 gm. and heart 0·828 gm. The respective weights in rats treated with a large dose of thyroid hormones were 9·53, 2·41 and 1·158 gm.; in rats, receiving androsterone and thyroid hormones 10·75, 2·44 and 1·345 gm.; in rats receiving œstrogenic and thyroid hormones 13·2, 2·98 and 1·383 gm., while in rats receiving œstrogen alone 9·03, 1·79 and 0·921 gm.

On the other hand, the hypertrophy of the adrenals and the retardation of body growth produced by thyroid hormones was decreased when male hormones were administered simultaneously, the latter exerting a partial neutralizing (antagonistic) action on these effects of thyroid hormones.

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London, S.W.1. May 15.

Blackening of Potato Tubers on Boiling

IT has been shown that the black coloration which appears in some potato tubers after boiling cannot be melanin, as the colour disappears rapidly in acid solution at about *p*H 3·0; at this *p*H melanin is quite stable. The bleached pigment appears to be soluble in acid solution, but the grey coloration partially reappears on neutralizing the acid with buffer solution at *p*H 7·0. No correlation was observed between the development of the pigment and the activity of the enzyme tyrosinase as estimated by the Warburg technique. Neither could any correlation be found between the blackening and the tyrosine content of the potatoes. It was observed that among the varieties tested there appeared to be two distinct levels of tyrosine content: King Edward and Majestic with 40–60 mgm. per 100 gm. fresh weight, and Kerr's Pink and Arran Banner with 8–25 mgm.

The pigment was found to develop as well after heating in alcohol as in water, but in neither case did it appear until oxygen was admitted. The pigment and its colourless precursor were both insoluble in 60 per cent alcohol. As shown by the unpublished work of Pearse, pieces of potato 1 cm. thick require a minimum of two minutes boiling for any black colour to develop, and for full coloration a total of five minutes is required, although this can be spread over several separate periods.

Attempts to isolate the grey pigment from boiled potato failed, but led to the suspicion that the pigment might be an iron compound. Estimation of the iron content of a large number of tubers showed a marked correlation between iron content (as extracted by 20 per cent sulphuric acid) and the incidence of blackening in tubers drawn from the same sample; blackening tubers contained in every case more iron than the normal ones. The correlation was not so clear when comparison was made between tubers from different samples, but on this point further work is required.

Nearly the whole of the extractable iron in the tubers appeared to be in the ferrous state. No reliable results for total iron could be obtained by micro-incineration of the material in acid as a very considerable exchange of iron was found to take place between the solutions and the glass of the incineration tubes. The evidence suggested, however, that under the conditions employed the whole or nearly the whole of the iron was extracted by the acid.

It was found that non-blackening tubers could be made to blacken by soaking for some days in 1 per cent ferrous sulphate, washing away the excess and boiling. On exposure to air they developed a very dark greenish-black colour, similar to that found in ordinary blackening tubers, but more intense; this pigment also was rapidly bleached at *p*H 3·0. It was also observed that white ferrous hydroxide, precipitated from solution, gradually oxidized, passing through green to the magnetic black oxide.

This work, carried out during 1936–39 with the help of a grant from the Potato Marketing Board, had to be interrupted at the outbreak of war. Though much remains to be done it is suggested, as a tentative hypothesis, that in the raw tubers the precursor of the black pigment exists in the form of ferrous iron bound in a loose complex, possibly in combination with proteins. This complex is hydrolysed on boiling and the iron is then precipitated as a colourless

ferrous compound, probably the hydroxide, which is gradually oxidized to the black oxide as air penetrates to the tissues. Although as yet supported by no direct evidence, this theory fits not only the facts established in the present work but also a number of hitherto unrelated observations of other workers in the same field, such as that of Tinckler[1] that the black pigmentation was induced in normal potatoes by contact with rusting iron during boiling, and the evidence obtained by Ross and Tottingham[2] that the proteins of blackening potatoes are more easily hydrolysable and autolysable than those of normal tubers.

I should like to thank Prof. V. H. Blackman for his advice and criticism throughout the course of this work.

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June 2.

[1] *Biochem. J.*, **25**, 773 (1931).
[2] *J. Agric. Res.*, **57**, 453 (1938).

Plagiophyres in an Intrusion at Downpatrick

IN 1937 B. C. King[1], in a petrographical examination of some Caledonian hypabyssal rocks from Kirkcudbrightshire, recorded the occurrence of plagiophyres in the dyke assemblage of this area.

Recent examination of a small intrusion at Slievenagriddle, two miles east of Downpatrick in Northern Ireland, has resulted in the discovery of this rock-type in the hypabyssal phase of the Newry 'granite' mass. The intrusion was originally recorded by the Geological Survey of Ireland[2], and on macroscopic examination was described by the Survey as syenite. In thin section the rock is seen to correspond closely to the Scottish plagiophyres; mafic minerals being entirely represented by chlorite, felspar and albite-oligoclase, abundant secondary calcite, etc.

Dykes of this Irish suite have been described from the Ards Peninsula[3] and the Killough-Ardglass coast[4], and are dominantly lamprophyric in these two areas. It is probable that further examination of this dyke-swarm towards the south-west (and the Newry 'granite') will reveal a more extensive variety of rock types than are at present known from the County Down area.

EDWARD M. PATTERSON.
Department of Geology,
Queen's University,
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[1] King, B. C., *Proc. Geol. Assoc.*, **48**, 282–306 (1937).
[2] *Mem. Geol. Surv. Ireland*, Sheets 49, 50, 61, pp. 15 and 47.
[3] Reynolds, D. *Ic. Geol. Mag.*, **68**, 97–111 and 145–165.
[4] Tomkieff, S. I., and Marshall, C. E., *Quart. J. Geol. Soc.*, **96**, 321–338.

Specific Heat of β-Brass

MY previous theoretical work[1], based on a method of approximation, has been criticized by Bethe and Kirkwood[2]. I have now carried out a rigorous evaluation of the partition function at constant volume, starting first with the two dimensional quadratic lattice.

Three partition functions are calculated successively, namely, $P(1)$, $P(n)$ and $P(n^2)$ which refer to: a square of four atoms, the 'elementary cell'; a ladder consisting of n elementary cells joining in one dimension; and the whole lattice, which consists of n ladders joined together with their lath.

$P(1)$ is a sum of eight terms according to the eight possible configurations of the cell. In order to account for the statistical correlations of the cells (the long-range order effect), the terms of $P(1)$ are considered to be the coefficients of a certain quadratic form in two variables and $P(n)$ to be the n-fold iterated quadratic form. Similarly, the terms of $P(n)$ are considered to be the coefficients of a quadratic form in 2^n variables and the n-fold iterated form to be equal to $P(n^2)$. In these calculations the form in a large number of variables is reduced to a product of forms in two variables.

In the limit, $n \to \infty$, $P(n^2)$ is found to be equal to $[p(x, y)]^{n^2}$ where $y = x = \exp(-\varphi/kT)$ and φ is a constant of the dimension of an energy. The mean energy is equal to $\varphi y \partial \log p/\partial y$. The function $p(x, y)$ has the following form:

$$p(x, y) = \tfrac{1}{2}\{(1+y)[(1-x^2)^2 + 8x^2(1+y) + (1-x^2)\sqrt{1+14x^2+x^4}] + \sqrt{2}[(1-x^2)^4(1-y)^2 + 32x^4(1+14y^2+y^4) + 8x^2(1-x^2)^2(2-3y+8y^2+y^3) + ((1-x^2)^3(1-y)^2 + 8x^2(1-x^2)(1-y+7y^2+y^3))\sqrt{1+14x^2+x^4}]^{1/2}\}\cdot[(1+14x^2+x^4) + (1-x^2)\sqrt{1+14x^2+x^4}]^{-1}.$$

It is independent of n and has no singularity. The specific heat curve has a broad maximum which has no resemblance to a λ-point.

The method applies to a lattice in three dimensions, and calculations are in progress.

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Davy Faraday Laboratory,
Albemarle Street,
London, W.1.
May 28.

[1] *Proc. Roy. Soc.*, A, **168**, 546 (1938).
[2] *J. Chem. Phys.*, **7**, 578 (1939).

Metallic Triazine Complexes

IN a recent note[1] referring to the palladium derivatives of diazoaminobenzene and of 4 : 4′-dimethyl-diazoaminobenzene described by Dwyer[2], it was stated that these compounds, containing one palladium atom united to three diazoaminobenzene units, "appear to be the first examples of hexacovalent palladous compounds [to be] described", this statement being made also by Dwyer in his original paper.

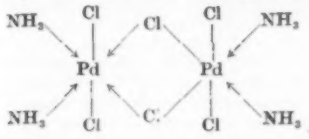
Actually, however, I have described the first such compounds[3], having prepared both platinous and palladous salts of αβγ-triamino-propane, the palladous derivative having the formula

$$[\{NH_2CH_2CH(NH_2)CH_2NH_2\}_2Pd]I_2.$$

Evidence was adduced to show that in such compounds all the amino-groups were co-ordinated to the metal, which was therefore undoubtedly hexacovalent.

Apart from this certain case, it is probable that the black crystalline compound[4] of empirical formula $(NH_3)_2PdCl_2$ has the constitution shown, containing one hexacovalent palladous and one hexacovalent palladic atom, bridged by the two chlorine atoms[5]. In this case the compound would exist as a resonance

hybrid, and this factor is probably intimately associated with the colour of the crystals.



Dr. Dwyer's paper contains many interesting points. It is particularly noteworthy that the *tris*-diazoaminobenzene-palladium readily lost a molecule of diazoaminobenzene, and that the *bis*-diazoaminobenzene-palladium so formed could not be converted back to the original *tris*-derivative. This is not unexpected. The *bis*-derivative, having undoubtedly the planar configuration, could not undergo simple union with a third molecule of diazoaminobenzene, since the latter molecule would be unable to span the 1 : 6 position of the potential hexacovalent octahedron. The union would therefore be a complex process leading to an unstable compound, and hence does not apparently occur. I have discussed other cases of this phenomenon elsewhere[6].

F. G. MANN.

University Chemical Laboratory,
Cambridge.

[1] NATURE, **147**, 612 (1941).
[2] *J. Amer. Chem. Soc.*, **63**, 78 (1941).
[3] *J. Chem. Soc.*, 892 (1928); 654 (1929).
[4] Drew, Pinkard, Preston and Wardlaw, *J. Chem. Soc.*, 1898 (1332).
[5] Mann and Purdie, *J. Chem. Soc.*, 881 (1936)
[6] *J. Chem. Soc.*, 412 (1933).

Textures of Clays

PROBABLY the best method of evaluating the texture of a clay is to slake it up with water or break it up into its component parts by some method such as alternate drying and slaking, and then to size by combined sieve and pipette or hydrometer analyses. If this in turn is combined with microscopic examination, the grain shapes can be determined and an accurate conception can be obtained of the grain size distribution. The more detailed this size analysis the more valuable it is. However, without the mineralogical composition, the picture of the structure and texture is very incomplete. To quote an extreme case, a kaolin consisting of particles 95 per cent less than 43 microns and the main mineral being kaolinite, may be only slightly plastic, whereas another clay having about 50 per cent of its particles less than 43 microns in diameter but containing water-swelling minerals of the montmorillonite group may be very plastic and have a very high modulus of rupture as well.

To take two examples, the mechanical analyses were as follows:

	1	2
Coarse sand	4·30	nil
Fine sand	24·80	1·23
Silt	35·60	37·90
Clay	28·80	61·12
Moisture	3·57	0·05
	97·07	100·30

1. Red clay from Port Elizabeth.
2. Washed kaolin from George, Cape Province.

At first glance one would be inclined to say that the second specimen would be the more plastic. Actually the kaolin is practically non-plastic although it is not hard and compact. The first sample contains some vermicular kaolinite, but is mainly composed of ferruginous clay minerals and illite. The second is composed almost wholely of kaolinite with some quartz. The kaolinite is platey and there is a high degree of coarse crystallinity. The first clay has a modulus of rupture of 390 lb./sq. in., whereas the value for the kaolin is less than 10 lb./sq. in.

Actually this type of analysis is not discriminating enough, and in later work the conventional size separates used by soil scientists was abandoned. The sub-sieve sizes were then dealt with in the following manner:—43–31, 31–16, 16–11, 11–5·5, 5·5–2·0, 2·0–1·0 microns, or as the texture of the clay varied. The method is flexible and the ultimate aim is to get the size distribution of the clay, rather than to fit the clay to a conventional nomenclature. If it is desired to compare the size distribution of two or more clays this can be best done graphically.

A problem that has not been solved is the condition of the organic phases[1]. The organic compounds are, with the exception of grass roots, etc., always associated with the finest sizes. That plasticity, green strength and other physical properties are influenced by the presence or absence of the peaty substances present in certain fireclays, kaolins and bog clays is evident from an examination of such rocks. In the case of a certain sedimentary kaolin, certain phases of the same clay contained organic matter and others did not. The difference in plasticity was striking.

V. L. BOSAZZA.

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Johannesburg.

[1] Bosazza, V. L., NATURE, **144**, 835 (1939).

Sense of Hearing in Fishes

I AM sure that the fish described in Dr. C. B. Williams' communication[1] did hear the bicycle bell, as a disturbance of the norm to which it is 'conditioned'. Dr. Bull has had to make a sound-proof room for his experiments at Cullercoats on the behaviour of blennies, etc.[2]

But the simplicity of the inner ear of fish, in which there is only an otolith floating in a saccule to serve instead of the graded tuning-forks of the mammalian cochlea, allows us to expect most fish to be rather hard of hearing, except in examples where we know to the contrary. The degree of hearing must vary from species to species, because the acoustic region of the brain shows varying degrees of development, even within one family; and some fish have well-developed 'aids to the deaf' made from part of the swim bladder, for example, in carp and herring. All this, and more, is to be found in Dr. H. Muir Evans's recent book[3]. Dr. Evans's researches show that fishes have more elaborate organs of reception and perception than the text-books have led us to suppose. Sight, hearing and taste may all be well developed, and in varying degrees, and in a few species there is a genuine under-water voice.

MICHAEL GRAHAM.

Fisheries Laboratory,
Lowestoft.
May 9.

[1] NATURE, **147**, 543 (1941).
[2] Dove Rep. (1934).
[3] "The Brain and Body of Fish" (Technical Press, 1940)

RESEARCH ITEMS

Changes in Amputated Nerveless Limbs of Urodele Larvæ

O. E. Schotté and E. G. Butler described the above morphological changes in a paper read on April 29 at the annual meeting of the U.S. National Academy of Sciences. By repeated resections of the brachial plexus, fore-limbs of Urodele larvæ have been maintained in a nerveless condition for several weeks, and in some cases for as long as two months. A limb, completely devoid of spinal innervation, not only loses its capacity for regeneration, but also, after amputation, it undergoes radical morphological changes. Beginning at the level of amputation and proceeding proximally, structures of an amputated nerveless limb undergo regression and resorption. This structural regression brings about extreme reduction in size and eventually complete disappearance of the limb. Histological studies demonstrate that the regression is the result primarily of cellular dedifferentiation. All formed structures of the limb, including skeleton and muscles, go into extreme dedifferentiation and gradually disappear. Moreover, dedifferentiation in a nerveless limb involves not only those structures injured at the time of amputation, but also those remote from the amputation level. Articulations do not serve as barriers to the dedifferentiative processes. These radical morphological changes are not the result primarily of physiological atrophy, but represent alterations in the specific character of limb tissues, caused by the disturbed unrolling of regenerative processes. Since control experiments show that denervation alone only impedes further growth processes, but is not followed by regression of structures, the above results reveal the importance of amputation for the normal course of regeneration. Unamputated nerveless limbs exhibit no dedifferentiation; amputated nerveless limbs show extreme dedifferentiation and reduction, leading to eventual disappearance of the limb. The nervous system, therefore, formerly regarded as exerting primarily a trophic influence on cellular activities during regeneration, must now be considered as an important agent of the organism as a whole, enabling amputated limbs to carry on the complex cellular interactions for regeneration.

Field Properties of the Developing Frog's Egg

EXPERIMENTAL observations on these properties were described by H. S. Burr, on April 29, at the annual meeting of the U.S. National Academy of Sciences. Some six thousand determinations were made on fifty frogs' eggs prior to the development of the long axis of the embryo as seen in the appearance of the medullary plate. Potential differences between the vertex of the animal pole and four equidistant points on the equator of the egg were measured by the Burr–Lane–Nims technique. Three variations in the technique were employed and all were subjected to statistical analysis. From the very beginning it was apparent that at least one of the four points showed a significantly greater voltage drop from the vertex than any of the other three. This point was then marked either by staining by Nile Blue sulphate or by the establishment of orientation points in the immediate environment of the egg. Of the fifty embryos, ten were marked successfully and developed to the neural plate stage. In the remaining forty, correlations were either not attempted or were impossible because of technical difficulties. It should be noted that the technique is rigorous and requires great care in its manipulation, and technical artefacts therefore frequently creep into the study. In every case where correlations were possible, the primary axis of the organism came to lie along the plane which showed the greatest voltage drop from the vertex. In other words, it was possible to predict from the voltage pattern where the head end of the organism would develop. It is hard to escape the conclusion, therefore, that the electrical pattern is primary, and, in some measure at least, determines the morphological pattern. Added weight is given to the argument by other observed facts.

Effects of β-Naphthoxyacetic Acid on Plants

P. W. ZIMMERMAN described some studies of this subject on April 28 at the annual meeting of the U.S. National Academy of Sciences. Many growth substances have in common the capacity of inducing similar responses in plants; that is, they cause cell elongation, increase cell division, and induce adventitious roots. There are, however, many qualitative differences in the capacity of chemically similar compounds to induce physiological responses. For example, β-naphthoxyacetic acid and its derivatives modify the new organs (leaves, stems, flowers and fruit) which are formed after the growing points are treated with the substance. The pattern and venation of compound leaves become modified, appearing frenched and fasciated. Leaflets frequently grow together on portions of compound leaves. Compound types sometimes become simple leaves and again doubly compound. Both the pattern and opaqueness of veins are modified. Veins of modified leaves show clearing which is usually characteristic of virus-diseased plants. Tobacco plants sprayed at the tip with a solution (300 mgm./l.) of β-naphthoxyacetic acid grow taller and flower ahead of controls. Treated delphinium plants also flower ahead of controls. Unless plants are re-treated at intervals they recover and again produce normal leaves and flowers. Parthenocarpic development of tomato fruit is induced when flowers or well-developed buds are sprayed with emulsions or solutions of naphthoxyacetic acid. The ovaries often enlarge before the flowers open, eventually breaking through on one side of the calyx tube. The floral parts—petals, stamens and pistils—persist for an abnormally long time during parthenocarpic development. In some cases both petals and stamens remain in good condition for 30 days whereas controls wither within 3 days after the flowers open. Compared with other growth substances, naphthoxyacetic acid has several advantages for practical production of seedless tomatoes and possibly of other fruits.

Biotin and the Growth of *Fusarium avenaceum*.

THE effect of biotin on the growth of *Fusarium avenaceum* was described in a paper by W. J. Robbins read on April 28 at the annual meeting of the U.S. National Academy of Sciences. A strain of *Fusarium avenaceum* obtained from South America does not

grow in a solution of mineral salts and sugar but grows in the same solution solidified with agar. The beneficial effect of agar on the growth of this organism is chiefly because of biotin (vitamin H) present in the agar. Purification of the agar by extraction with aqueous pyridine removes the biotin and makes the agar ineffective in permitting growth of the fungus. The amount of biotin present varies with the sample of agar, but approximates to 0·1 microgram per gram in some samples. This is as much or more than is present in dried egg yolk. Agar was more beneficial than could be accounted for by its biotin content. A beneficial effect of 0·001 microgram of pure biotin (obtained from Dr. Vincent du Vigneaud) on the growth of the Fusarium in liquid culture was observed and amounts of biotin up to 0·1 microgram per culture further increased the dry weight. Some isolations made from old cultures of the fungus grew in the absence of biotin; these were interpreted to be saltations or dissociations.

Nitrogen/Phosphorus Relations in Lemon Seedlings

In a paper read before the Royal Society of South Africa on March 19, J. W. Pont discussed the nitrogen–phosphorus relations in Rough lemon seedlings. No negative correlation between nitrogen and phosphorus could be observed in either the leaves, the stems or the roots. A positive correlation between nitrogen and phosphorus existed in the roots only. Roots, stems and leaves form distinct metabolic systems, and it appears plausible to accept that fruits form a separate system.

Drainage of the Fens

The problem of the disposal of the Ouse floods and the Fen drainage has been much to the fore since the heavy floods of a few years ago. The various schemes that have been suggested are described and discussed by W. E. Doran in a paper on the Ouse flood problem in the *Geographical Journal* of April. Perhaps the most striking of the various proposals is that by Sir Murdoch MacDonald and Partners. This entails intercepting the upland waters in the headstreams of the Ouse and preventing them passing through the Fen area. It would involve the construction of a circular canal to the east of the Fens from the Cam at Grantchester via the Lark, the Little Ouse and the Wissey, at Stoke Ferry, to Denver, whence a new canal, suggested also by other authorities, would carry the water roughly parallel with the Ouse but more direct, to the main river at St. Germans. It is only as high up the Cam as Grantchester that a suitable level for the flow of water down this channel could be reached. Hence the impossibility of beginning it below Cambridge. Further details of the scheme, and the location of sluices and pumping stations, are explained in the paper and its accompanying map.

Divisions of the Pleistocene

The correlation of Pleistocene deposits throughout the world presents many difficulties. In a paper on this subject (*Trans. Roy. Soc. Edin.*, **60**, Part II, No. 11) T. T. Paterson points to the imperfection of the fossil record, the shortness of the whole period and consequent difficulty of subdivisions based on faunal development, and largely, the stress that has been laid on different phenomena in studies of the period in different lands. He surveys the available evidence from a wide area, examining especially the fluviatile deposits, and he amplifies the scanty fossil record by the use of palæolithic horizons. To these he pays particular attention and gives a survey of culture development during the period. Paterson concludes that variations in power-volume, the result of combined orogenic and precipitational changes, are coincident throughout the Old World. The variations result in three great cycles of sedimentation divisible into seven phases. The first, second and third glacial episodes coincide with the beginning of each cycle, and the fourth with the third phase of the last cycle. The fifth glacial episode marks the end of the Pleistocene. It is proposed to divide the Pleistocene into Lower, Middle and Upper, with seven phases termed L_1 L_2 M_1 M_2 U_1 U_2 U_3, to show their relationship with the three major subdivisions (see also NATURE, **146**, 12–15 and 49–52; 1940). In a discussion on the causes of power-volume changes, Paterson concludes that G. C. Simpson's theory of variation in solar radiation explains most of the phenomena.

Electrophoretic Study of Complexes between Proteins, etc.

D. A. MacInnes and L. G. Longworth described some experimental work in the above connexion before the annual meeting of the U.S. National Academy of Sciences, on April 29. In their study of egg white, by a modification of the method of Tiselius, evidence was obtained that complexes exist between the proteins in the naturally occurring material and also in salt and buffer solutions. The evidence comes largely from the fact that in certain cases the electrophoretic patterns for the rising and descending boundaries are not, even approximately, mirror images of each other, as would be expected if the components were electrophoretically independent. The effect is greatest for relatively high protein concentrations and low salt contents of the solutions used in the studies. Complexes are most often found between proteins on opposite sides of their isoelectric points, but this is by no means a necessary condition for their occurrence. As type systems, electrophoretic studies have been carried out systematically on mixtures of ovalbumin and yeast nucleic acid, and on this nucleic acid with ovomucoid, varying the relative concentrations, the *p*H values and the ionic strengths. The electrophoretic pattern for a mixture of ovomucoid and nucleic acid is particularly interesting in that it indicates a peak for an extra component. The apparent relative concentrations, as indicated by the areas under the different peaks of the patterns, are altered by complex formation. With the mixture of ovalbumin and nucleic acid the components were found to form complexes if the *p*H were near or below the isoelectric point of ovalbumin, but to be electrophoretically quite independent at high *p*H values.

Temperature and Variations of Cosmic-Ray Intensity

The correlation between the seasonal variations of cosmic-ray intensity and temperature of the atmosphere are examined by A. Duperier (*Proc. Roy. Soc.*, A, **177**, 204; 1941) using data for Europe and the United States. A lag in the warming of the atmosphere in spring is found to be paralleled by a lag in the diminution of intensity of the cosmic rays. The correlation is closer with the mean temperature of the atmosphere up to 16 km. than with temperature near the ground. The temperature coefficient of the cosmic rays as deduced from the seasonal data is 0·18 per cent per degree C., in rough agreement with theory.

ÆSTHETIC APPEAL OF OSTWALD'S CHROMATIC STANDARDS

By Dr. J. B. Parry
University College, London

In NATURE of May 31, p. 682, Dr. H. J. Eysenck has examined a number of claims made by Ostwald for his colour system. It may be of interest to put on record two experiments I have recently carried out relating to the æsthetic appeal of Ostwald's chromatic circles; the first deals with the appeal of single hues, the second with that of triple combinations. The detailed account of the experiments will be found in my Ph.D. thesis (London, 1940) entitled "The Rôle of Attention in Æsthetic Experience".

Preferences for Single Hues

It is desirable to explain that, according to Ostwald, the physical composition of any colour stimulus may be shown by an equation of the form: Hue + Black + White = 1. Circles, known as isovalents, can be defined, for any one of which the same equation holds for all its members, only the hue quality varying from one member to another. A condensed formula for each circle is given by two letters, the first indicating the proportion of white content, the second that of black content. There are of course many tint circles ranging from near white to near saturation and many shade circles from near black to near saturation; those selected here are intermediate.

The materials for the first experiment were twenty-four Ostwald papers cut to the size of 3¼ in. square and backed with stiff cardboard. The selection comprised three sets of eight items each, the first containing fully saturated hues (circle *na*), the second tints (circle *ga*) and the third shades (circle *ng*). In each set the middle values of the eight principal hues were chosen. Fifteen educated persons were asked to grade these items according to preference by linear ranking, the test being performed in daylight against a background of white blotting-paper.

Factorial analysis of the resultant intercorrelations of persons by simple summation revealed a first factor responsible for 26·5 per cent of the variance. From this it seems clear that there is a strong tendency to general agreement as to the pleasantness or unpleasantness of single hues.

The relative popularity of the individual items may be estimated by summing the positions allotted to each by the fifteen subjects. From the resultant order of popularity of twenty-four items one can of course abstract an order of popularity for the eight hues in each of the three circles. These latter orders are shown in the following table, the figures in brackets showing the positions of the items in the order of popularity of all twenty-four items.

Order of Popularity of the Items in the Three Circles

Circle Hue	*na* (Full Saturation)	*ga* (Tints)	*ng* (Shades)
Yellow	7 (20)	8 (18)	8 (24)
Orange	6 (15)	7 (22)	6 (17)
Red	1 (1)	4 (9)	4 (13)
Purple	5 (14)	6 (21)	5 (16)
Ultramarine	2 (2)	3 (8)	1 (7)
Turquoise	4 (6)	1 (3)	7 (19)
Sea Green	3 (4)	2 (4)	2 (11)
Leaf Green	8 (23)	5 (10)	3 11)

The high positions of all three ultramarines and sea greens and the marked unpopularity of the oranges and yellows will be noted.

Preference for Triple Combinations

Ostwald makes two specific claims regarding the appeal of triple combinations: first, that membership of the same circle is a condition favouring harmony; secondly, that among terms fulfilling this condition, equality in the psychological intervals between the terms is a further favouring condition (this second claim rests on the assumption that the intervals between successive terms on any Ostwald circle are all psychologically equal); this point was one of many investigated by Prof. C. Burt a number of years ago—he reached the conclusion that the intervals were often far from equal, an opinion also expressed by Eysenck in his recent article in this journal.

In framing the following test Ostwald's claims were borne in mind. The materials for this second test consisted of 24 triple combinations, comprising four groups:

(1) Eight equally spaced combinations from the standard hue circle *na* (for example, 1, 9, 17; 7, 15, 23, etc.). In this group both the above conditions are realized.

(2) Eight unequally spaced combinations from the standard hue circle, each of the four possible degrees of inequality being represented twice (for example, 1, 16, 17; 2, 15, 18; 3, 14, 19; 4, 13, 20). In this group the first of the above conditions is realized, the second is violated.

(3) Four equally spaced combinations, the three terms of each combination being drawn from three different circles, namely, the standard hue circle *na*, a tint circle *ia*, and a shade circle *ne*. Here the first condition is violated and the second observed.

(4) Four combinations (two equally spaced, two unequally spaced) from a grey shade circle *ie*.

Fourteen persons, all but one adult, were asked to award marks to groups of these on the principle: 8 marks to the one liked best, 7 to the next best, 6 to each of the next three . . . 0 to the one liked least. The test was carried out in daylight against a background of ordinary newsprint. Factorial analysis showed a first factor covering 31·66 per cent of the variance and a significant second factor accounting for a further 22·81 per cent.

The most impressive fact revealed by inspection of the preferences is that the seven subjects whose rankings approximate most closely to the average order have accorded maximum marks to the four greyed combinations; of the remaining seven, five have placed the members of this group slightly lower than midway, one has marked them very high and one very low. But this preference does not entirely account for the first factor discovered.

The four combinations with very unequal intervals were found extremely unpleasing by all but one of the subjects. This appears at first to support Ost-

wald's contention that the basis of harmony is equality of spacing; when, however, we compare the marks allotted to the equally spaced combinations with those that show a moderate inequality we find no further confirmation of the claim. As for the claim that membership of the same circle is a condition favouring harmony, the evidence at our disposal points, if anything, the other way.

Since no amount of inspection enabled me to discern the nature of the second factor, I decided to carry out a second test removing the four greyed combinations and the three least popular of the unequally spaced combinations. I then asked a dozen people (ten of whom had done the previous test) to range the remaining seventeen combinations by linear method. The results brought to light a truly dominating bipolar factor. Inspection of the items most diversely judged reveals two characters that it is easier to perceive than name. Some idea of the characters may possibly be indicated by pointing out that the leading members of one set each contained a pale green and a pale red, while those of the other set contained orange-yellows and deep greens. What is of special psychological interest is that no trace of this factor can be seen in the results of the original test, in which, of course, all the seventeen items were included. It appears that before these characters could be attended to, other more striking qualities such as greyedness and wide inequality of interval had to be eliminated. Once this has been done, these characters carry all before them.

In these tests of triple combinations, the three terms in each item were made to cover equal areas. This, of course, made it improbable that anything like the most pleasing combinations were reached. To achieve this result many more experiments would be necessary, and I hope in due time to carry these out. But the relative unpleasantness of the items in the tests so far done has not made it impossible to discern some of the principles influencing subjects in their assessment of the relative merits of colour combinations. What stands out with especial clearness is the complexity of the problem of colour harmony; any attempt, like Ostwald's, to explain it by a single principle seems foredoomed to failure.

THE BONE-BEARING BEDS OF BETHLEHEM

THE excavation of the bone-bearing beds of Bethlehem was undertaken by the Wellcome Archæological Expedition to the Near East under the auspices of the Department of Antiquities, Palestine, and work was carried on for three seasons (1935–7) with E. W. Gardner as geologist and D. M. A. Bate as palæontologist. The continuation of the work in 1937 was made possible through the support of the trustees of the late Sir Henry Wellcome, and of the late Sir Robert Mond. A preliminary account of the results was published in NATURE of September 4, 1937.

No work was done on the site in 1938 or 1939, but last year (1940) the co-operation of Dr. Stekelis of the Hebrew University was enlisted to complete the excavation so far as possible. His report has now been received and shows that some notable results have been achieved. In the area from which specimens had already been obtained, work was continued to a depth of several metres below the last occurrence of animal remains, but it was not possible to test the horizontal extent of the bone bed. The geological and archæological finds do not seem to provide very definite or final evidence regarding the history, or the possible human occupation of the site, but an interesting suggestion is made by Dr. Stekelis that a number of split bones collected may have been worked by man. A detailed study and comparison of these specimens should prove of exceptional interest.

A considerable quantity of animal remains was obtained, and the specimens will be sent in due course to the British Museum (Natural History) for study and description, together with those of the earlier collections. Dr. Stekelis's list shows that at least six species are recognized; they are as follows:

Bos sp.	Rhinoceros sp.
Antelope	Elephas sp.
Equus sp. (? Hipparion)	Testudo sp.

A number of valuable specimens were recovered and these include a mandibular ramus with teeth, and an almost complete skull with cheek teeth of Rhinoceros; Elephas or Stegodon is represented by a ramus with molars, as well as by isolated teeth and limb bones. Portions of jaws with teeth of antelope, and various remains of ox are also present. All these should be of value not only for determining the species, but also in interpreting the geological age and the relationship and status of this very interesting fossil fauna.

D. M. A. B.

VELOCITIES OF EARTHQUAKE WAVES

FRANCIS BIRCH has published a paper entitled "The Variation of Seismic Velocities within a Simplified Earth Model, in accordance with the Theory of Finite Strain" (Paper 55, Geophysical Research, Harvard University), which marks a somewhat new direction for seismological research.

The author states that the treatment of many problems concerning the elasticity of the earth as a whole has been handicapped by the lack of an adequate theory of finite deformation, which would permit quantitative estimation of the effects of the initial strain of the material below the surface. While certain artifices which have been employed to evade this difficulty have had the merit of adding a sufficient number of conditions to allow the solution of various special problems, they have proved

incapable of answering such fundamental questions as "Given a layer or a spherical shell of perfectly elastic (not incompressible) material, isotropic, homogeneous, and at uniform temperature, to find the variation of density and of the velocities of elastic waves due to self-compression in a gravitational field". Answers to these questions may naturally be sought in the results of high-pressure experiments, but at best the pressures realizable in the laboratory correspond to small depths in relation to the earth's radius.

A theory which will allow quantitative prediction of the effect of pressure upon density and elasticities can evidently be of great assistance in dealing with the vast region which will probably always remain beyond the range of experimental technique. In the opinion of Mr. Birch, a theory of this character has recently been provided by F. D. Murnaghan ("Finite Deformations of an Elastic Solid", *Amer. J. Math.*, **59**, 235–260; 1937), and Birch applies the theory to a study of the density and velocity variations in a simplified model of the earth outside the core, consisting of two homogeneous layers at uniform temperature. The layers are separated by a first order discontinuity at a depth of 474 km. (after Jeffreys). The velocities obtained are in fair agreement with those obtained by Jeffreys and Bullen, and the variations of density are very similar to those derived by Jeffreys and Bullen by numerical integration of the 'observed' velocities, on the supposition of adiabatic compression of homogeneous layers. The validity of their method is shown to depend upon the existence of a small temperature gradient, or of compensating factors which cannot be evaluated. It is suggested that a more rigorous solution of the equations of motion derived from the theory of finite strain might prove of value in interpreting the oscillatory character of seismic records, as well as the direction of the ground motion associated with various wave types.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DEPUTY DIRECTOR OF EDUCATION—The Director of Education, Education Office, St. Helens (endorsed 'Deputy Director of Education') (June 27).

DEMONSTRATOR in the Department of Zoology—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (June 28).

ASSISTANT to the Engineer-in-Chief—The General Manager and Secretary, Mersey Docks and Harbour Board, Dock Office Liverpool (June 30).

PROFESSOR OF PHYSIOLOGY at the London (Royal Free Hospital) School of Medicine for Women—The Academic Registrar, University of London, Royal Holloway College, Englefield Green, Surrey (July 1).

AGRICULTURAL MARKETING ADVISER to the Government of India—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (July 2).

ASSISTANT DIRECTOR OF EDUCATION—The Director of Education, Education Office, Becket Street, Derby.

FORTHCOMING EVENTS

Monday, June 23

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 3 p.m.—Annual General Meeting. (Presidential Address.)

Tuesday, June 24

ROYAL ANTHROPOLOGICAL INSTITUTE of Great Britain and Ireland (at 21 Bedford Square, London, W.C.1), at 2.30 p.m.—Annual General Meeting. Prof. A. R. Radcliffe-Brown: "The Study of Kinship" (Presidential Address).

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Empire Cotton Growing Corporation. Progress Reports from Experiment Stations, Season 1939–1940; Programmes of Experiments, Season 1940–1941. Pp. vi+176. (London: Empire Cotton Growing Corporation.) [235

River Flow Records of the River Moriston at Invermoriston for the Water-Years ending respectively on September 30th of 1938, 1939 and 1940. By Capt. W. N. McClean. Pp. 10. (London: River Flow Records.) [265

The Zoological Record. Vol. 76: Being Records of Zoological Literature relating chiefly to the Year 1939. Compiled for the Zoological Society of London by A. G. Brighton, M. Burton, A. B. Hastings, C. A. Hoare, W. Nicoll, A. E. Salisbury, J. K. S. St. Joseph, W. L. Sclater, M. A. Smith, C. J. Stubblefield, E. Trewavas, E. I. White, R. J. Whittick, and the Imperial Institute of Entomology. Edited by Malcolm A. Smith. Pp. 1420. (London: Zoological Society of London.) £3; also issued in 19 separate Sections. [285

Other Countries

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